# TECHNICAL AND ECONOMIC ASSESSMENT OF THE APPLICATION OF MEMBRANE TECHNOLOGY FOR TREATING OIL/WATER/MINERAL EMULSIONS

## FINAL REPORT

## VOLUME III - APPENDICES

Report Prepared for

**CANMET/ERL**

Department of Energy, Mines, and Resources, Canada

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by

**ZENON ENVIRONMENTAL INC.**

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# APPENDIX A

# ANALYTICAL PROCEDURES

# APPENDIX A

## ANALYTICAL PROCEDURES

### pH

The pH was determined using an Extech Model 651 digital meter (Extech, Boston, Mass.) following the method described in the operating manual.

### Conductivity

The conductivity was determined using a Beckman conductivity bridge Model GC-16B2 (Beckman Instruments, Inc., Fullerton, California) following the method described in the operating manual.

### Turbidity

The turbidity of the samples was determined using a HF Instruments Model DRT 100 Turbidimeter as per the instruction manual.

### Total Organic Carbon (TOC)

The TOC was determined using a Beckman Model 915 TOC analyzer (Beckman Instruments, Inc., Fullerton, California) following the method described in the operating manual.

### Filtered Organic Carbon (FOC)

1) Filter sample through a prewashed Whatman GFC glass fiber filter.

2) Determine TOC using a Beckman Model 915 TOC analyzer (Beckman Instruments, Inc. Fullerton, California) following method described in operating manual.

Total Suspended Oil (TSO) and Total Suspended Solids (TSS)

1) Filter known volume (V) of sample through a washed, ashed, and preweighed ($W_1$) Whatman glass fiber filter.
2) Dry filter overnight at 100°C.
3) Weigh filter ($W_2$).
4) Ash filter. Care must be taken to increase temperature slowly from 150°C to 450°C to volatilize oil without burning. Muffle for 1 hour at 450°C.
5) Weigh filter ($W_3$)
6) Calculations:

$$TSO = \frac{W_2 - W_3}{V} \qquad TSS = \frac{W_3 - W_1}{V}$$

note : Weight loss at 100°C assumed to be only water - along with water loss there may be a loss of the low-boiling components of the oil - resulting in a low TSO value.

Total Dissolved Solids (TDS) and Total Dissolved Oil (TDO)

1) Weigh crucible ($W_1$).
2) Transfer all filtrate from TSS + TSO determination of known volume (V) to crucible.
3) Dry crucible overnight at 60°C, dessicate, and weigh ($W_2$).
4) Ash residual in crucible. Muffle for 1 hour at 450°C.
5) Dessicate and weigh crucible ($W_3$)

6) Calculations:

$$\text{TDS} = \frac{W_2 - W_1}{V} \qquad \text{TDO} = \frac{W_3 - W_1}{V}$$

## Anion Scan (IC)

Samples were analyzed using Ion Chromatography for Cl, $PO_4$, $SO_4$, $NO_3$, $NO_2$, and F. Results were reported in mg/L.

## Cation Scan (DCP)

The samples were analyzed by direct coupled plasma for Ag, Al, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sr, V, Zn. Results were reported in mg/L.

## Silica

Silica is determined on a filtered (0.45 micron) aliquot following the procedure described in AWWA Standard Methods 15/B (Molybdosilicate Method). Accurate determination of total silica in the raw emulsion was impossible as a result of interference from oil and other components.

## Calcium, Magnesium

1) Fitler sample through a prewashed Whatman GFC glass fiber filter.
2) Determine metals concentration using a Jarrel-Ash Atomic Absorption Spectrometer Model 82-500 (Jarrel-Ash Inc. Waltham, Mass.) following methods described in operating

manual (Calcium Analytical Method No. 9 Magnesium Analytical Method No. 18).

## Calculated Hardness

Total hardness is calculated by multiplying the concentration of Ca and Mg by the proper factor to obtain equivalent calcium carbonate, and by summing these $CaCO_3$ concentrations. To obtain the $CaCO_3$ equivalent (mg/L) of Ca and Mg, the concentrations were multiplied by 2.5 and 4.116 respectively.

## Oil, Grease, and Ethyl Acetate Extractable Surfactants

Attempts to extract oil and grease using freon were unsuccessful. A method was developed which involved breaking the emulsion and analyzing the separate components. A 200 mL aliquot of sample was frozen and allowed to thaw. The entire sample, except for a small amount of oil stuck to the inside of the container, was filtered through a No. 40 ashless filter. The solids portion on the filter was extracted with approximately 300 mL of freon as per the standard method for oil and grease determination, (AWWA Standard Methods, Procedure 503, Section C).

The filtrate was extracted 3 times, each time with 200 mL of ethyl acetate. During the third extraction, the pH was lowered to 1 with 1 mL of 1+1 $H_2SO_4$. The water phase from this extraction was separated and extracted with 50 mL of ethyl acetate. An additional 200 mL of ethyl acetate was added to the non aqueous phase to redissolve solids formed during the pH adjustment. The solvents were combined and residual water was removed by passing the sample through a filter of $NaSO_4$. The dried solvent was rotovaped and blown down with $N_2$ gas and weighed to determine the ethyl acetate extractable surfactant material in the oil remaining in the sample.

The oil remaining in the container was dissolved in toluene then blown down to determine the mass of this oil.

# Surfactants for the petroleum industry

## Organics Division

**Witco Chemical Corporation**

## Reverse Demulsifiers

**Witbreak RTC Oil-In-Water Demulsifiers**

Oil-in-water emulsions or "reverse" emulsions occur naturally in oilfield production, especially in low-gravity crude producing areas. These types of emulsions may contain 0.5 to 1 percent recoverable oil. Reverse demulsifiers are used to resolve these emulsions in order to recover more crude and produce clean water for easy disposal.

Oil-in-water demulsifiers find use in several industrial processes such as:

| | |
|---|---|
| Crude oil desalting — | Wash water must be treated to remove oil to permit easy disposal. |
| Industrial cleaning — | Solvent washing is used in certain industries and the solvent is subsequently removed in the process by a water/detergent solution. Solvents used may vary from hydrocarbons such as xylene or kerosene to chlorinated hydrocarbons. Resulting oil-in-water emulsions may present a disposal problem unless the oil is removed. Separation of the emulsions permits easy disposal of water and possible recycling of solvent. |
| Cutting oil emulsions — | Resolution of used cutting oil emulsions permits disposal of the water phase by conventional means. |

## Typical Properties

### Witbreak RTC-323

| | |
|---|---|
| Chemical Description | Polymeric Amine |
| Appearance | Liquid |
| pH, 5% in 3:1 Water/Isopropanol | 9 - 11 |
| Viscosity, Brookfield, at 25°C (77°F), cps | 660 - 760 |
| Pour Point, PMCC, °F | 25 |
| Flash Point, °F | >200 |
| Density, lb/gal | 8.5 |
| Solubility, 10% in | |
| Water | Soluble |
| Xylene | Insoluble |
| Isopropanol | Insoluble |
| Kerosene | Insoluble |

**No warranties, express or implied, including patent warranties or warranties of merchantability or fitness for use, are made by Witco Chemical Corporation with respect to products described or information set forth herein.** Nothing contained herein shall constitute a permission or recommendation to practice any invention covered by a patent without a license from the owner of the patent.

# APPENDIX B

# RESULTS OF EMULSION CHARACTERIZATION

**RESEARCH**
FOUNDATION

SHERIDAN PARK RESEARCH COMMUNITY
MISSISSAUGA, ONTARIO, CANADA [illegible] • (416) 822 41[illegible] • TELEX 06 982311

## MATERIALS DIVISION

## Non-Metallic Minerals Centre

## PARTICLE SIZE ANALYSIS OF A OIL/CLAY SUSPENSION

Fine Particle Laboratory Services
Report No. FPL 50005-84-19

M.P. Haley
May 28,1984

for

Zenon Environmental
845 Harrington Court
Burlington, Ontario
L7N 3P3

Attention: Ms. Chris Zienkowicz

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## 1. INTRODUCTION

One sample of a oil/clay suspension was submitted for particle size analysis of both the oil and clay fractions.

## 2. METHOD

The initial methodology to separate and analyze the two distinct fractions was to involve a Coulter Counter particle sizing on the raw material, followed by filtering a metered sample which could be collected, washed and analyzed using optical microscopy/image analysis. Unfortunately, the portion collected on the filter paper contained a large number of dark indefinite shapes which were attributed to the oil droplets present in the sample. By washing a portion of the sample with toluene in a separatory funnel, it was noted that the oil fraction could be separated thereby leaving the clay particles in the aqueous phase which could be collected on a filter. Following this procedure, however, posed certain problems in developing sufficient contrast of the clay particles to enable proper detection with the Quantimet image analysing computer. An alternate procedure was then attempted.

Since it had been shown that toluene was effective in removing the oil fraction from the clay particles, a 1 mL portion of the raw sample was washed with 50 mL of toluene in a separatory funnel. To this, 9 mL of Isoton (a particle free aqueous electrolyte) was added to aid in particle dispersion and separation. Once the oil had been removed from the aqueous phase (as noted by change in color of both the toluene and aqueous layers), the aqueous portion was collected for particle size analysis. Residual clay particles in the separatory funnel were washed through and collected with successive additions of Isoton. This sample was then analyzed on the Coulter Counter TAII.

ORF

Particle size measurement on both the raw sample and the toluene washed sample was conducted on the Coulter Counter TAII using a 70 µm aperture tube which provided an effective size range of 1.6 - 32+ µm. By preparing accurately diluted samples and metering a precise sample volume through the aperture tube, estimates of particle concentration, within the range stated above, could be deduced. To arrive at the size distribution for the oil droplets, the toluene washed sample data (e.g. clay particles) were subtracted from the total or raw sample.

## 3. RESULTS

Concentration estimates are presented in Table I while the size distribution (by volume and number) for the total, clay, and oil fractions are presented in the Appendices I - III.

TABLE I

| Fraction | Particle/mL Solution |
|---|---|
| Raw | $474.4 \times 10^4$ |
| Clay (Toluene Washed) | $34.1 \times 10^4$ |
| Oil (Raw - Clay) | $440.3 \times 10^4$ |

## 4. DISCUSSION

From the results of Table I, it appears that the majority of the "particles" observed in the raw solutions, are in fact oil droplets (~93%). The mean particle size for these oil droplets appears to be approximately 7.8 µm while that of the clay particulates is 9.8 µm.

Mike P. Haley
Mike P. Haley
Assistant Research Scientist

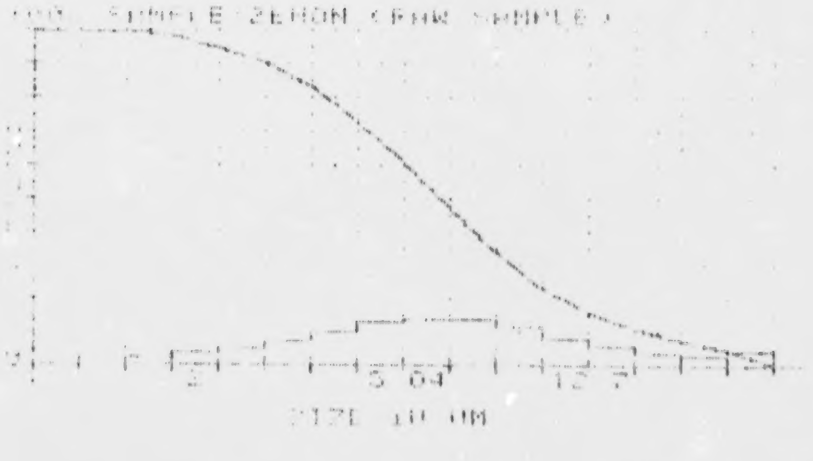
Ivan H. Joyce, Manager
Non-Metallic Minerals Centre

/gb

```
DATE: 25 MAY 1984
SAMPLE: ZENON (RAW SAMPLE)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURES: 70
OPERATOR: MFH
COMMENTS: DILUTED 4[illegible]
**************************************
CH. #   SIZE          DIFF        CUM
                      VOL %       VOL %
**************************************
1       1             0           100
2       1.26          0           100
3       1.59          1.8         100
4       2             3.4         98.2
5       2.52          4.8         94.81
6       3.17          7.19        90.01
7       4             9.19        82.82
8       5.04          12.35       73.63
9       6.35          13.45       [illegible]
10      8             13.39       4[illegible]
11      10.08         11.[illegible]    3[illegible]
12      12.7          7.43        2[illegible].61
13      16            5.09        15.18
14      20.16         3.6         10.09
15      25.4          2.8         6.49
16      32            3.7         3.[illegible]


SAMPLE: ZENON (RAW SAMPLE)10:[illegible] RAW
**************************************
        VOLUME % STATISTICS
**************************************

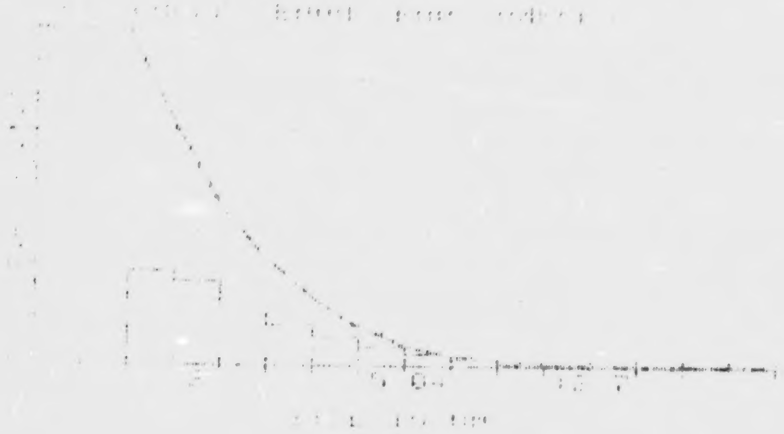
MEAN:                    7.79 UM
MEDIAN:                  7.62 UM
MODE                     7.85 UM
STANDARD DEVIATION:      2 UM
COEF. VAR.:              25.73%
SKEWNESS:                1.06 NEGATIVE
KURTOSIS:                1.86 PLATYKURTIC
```



```
DATE: 2[illegible] MAY 1984
SAMPLE: ZENON (RAW SAMPLE)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURES: 70
OPERATOR: MFH
COMMENTS: DILUTED 400X
****************************************
CH.#   SIZE          DIFF       CUM
                     POP %      POP %
****************************************
1      1             0          100
2      1.26          0          100
3      1.59          2[illegible].61      100
4      2             24.46      [illegible]
5      2.52          15.78      47.91
6      3.17          11.87      31.53
7      4             8.5[illegible]       1[illegible].66
8      5.04          5.4[illegible]       11.07
9      6.35          3.08       5.[illegible]4
10     [illegible]             1.[illegible]6       [illegible]6
11     10.08         .85        1
12     12.7          .2[illegible]        .[illegible]
13     16            .0[illegible]        .11
14     20.16         [illegible]          .04
15     25.4          .01        .02
16     [illegible]             .0[illegible]        .0[illegible]

SAMPLE: ZENON (RAW SAMPLE) ID: ZENON RAW
****************************************
       POPULATION STATISTICS
****************************************

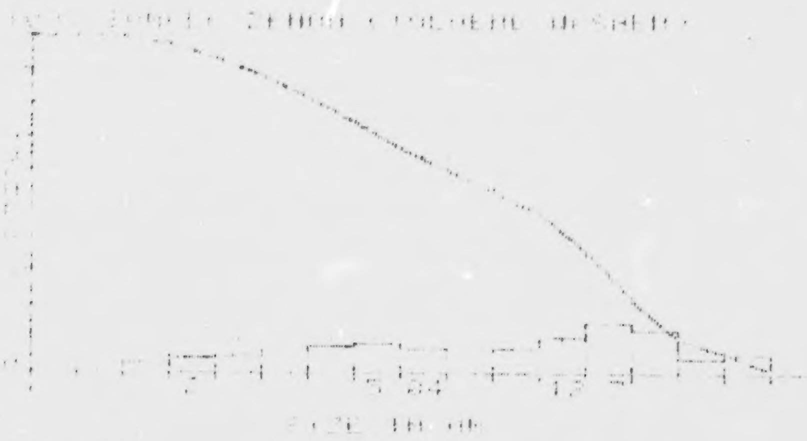
MEAN                     2.78 UM
MEDIAN                   2.47 UM
MODE                     1.93 UM
STANDARD DEVIATION       1.55 UM
COEF. VAR.               55.83%
SKEWNESS                 1.1 POSITIVE
KURTOSIS                 1.16 PLATYKURTIC
```



```
DATE: 25 DEC 1984
SAMPLE: ZENON (TOLUENE WASHED)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURES: 70
OPERATOR: MRH
COMMENTS: FILTERED [illegible]
*****************************************
CH.#   SIZE          DIFF      CUM
                     VOL %     VOL %
*****************************************
1      1             0         100
2      1.26          0         100
3      1.59          [illegible]  100
4      [illegible]   4.1       97.3
5      2.52          5         93.21
6      3.17          6.27      88.21
7      4             7.39      81.92
8      5.04          9.09      74.53
9      6.35          6.55      66.43
10     8             5.89      59.84
11     10.08         6.75      53.75
12     12.7          10.59     47.15
13     16            14.59     36.56
14     20.16         12.57     21.98
15     25.4          3.8       9.37
16     32            5.34      5.54

SAMPLE:ZENON (TOLUENE WASHED) ID:ZENON WASHED
*****************************************
         VOLUME % STATISTICS
*****************************************

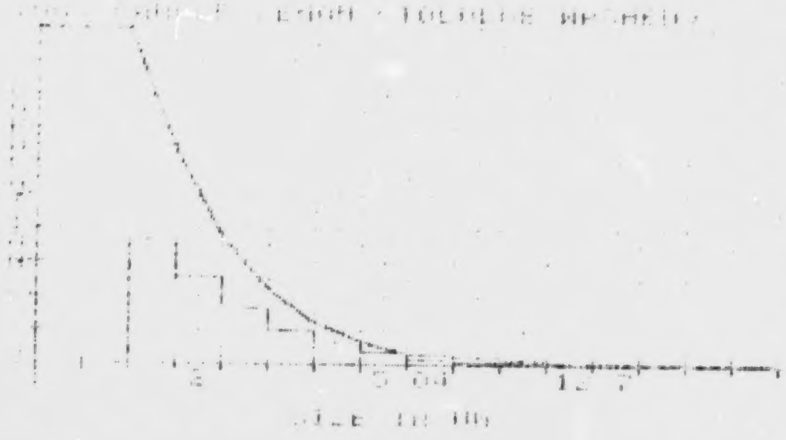
MEAN:                     9.76 UM
MEDIAN:                   11.53 UM
MODE:                     10.66 UM
STANDARD DEVIATION:       2.28 UM
COEF. VAR.:               23.39%
SKEWNESS:                 .83 NEGATIVE
KURTOSIS:                 2.34 PLATYKURTIC
```



```
DATE: 25 MAY 1984
SAMPLE: ZENON (TOLUENE WASHED)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURES: [illegible]
OPERATOR: MPH
COMMENTS: DILUTED 125
****************************************
CH.#    SIZE              DIFF      CUM
                          POP %     POP %
****************************************
1       1                 0         100
2       1.26              0         100
3       1.59              36.67     100
4       2                 25.8      63.37
5       2.52              15.83     37.53
6       3.17              9.91      21.7
7       4                 5.61      11.8
8       5.04              3.15      6.19
9       6.35              1.78      3.04
10      8                 .57       1.26
11      10.08             .34       .69
12      12.7              [illegible] .35
13      16                .16       .28
14      20.16             .06       .1
15      25.4              .01       .02
16      32                .01       .01


SAMPLE: ZENON (TOLUENE WASHED) IN: ZENON WASHED
** *************************************
        POPULATION STATISTICS
****************************************

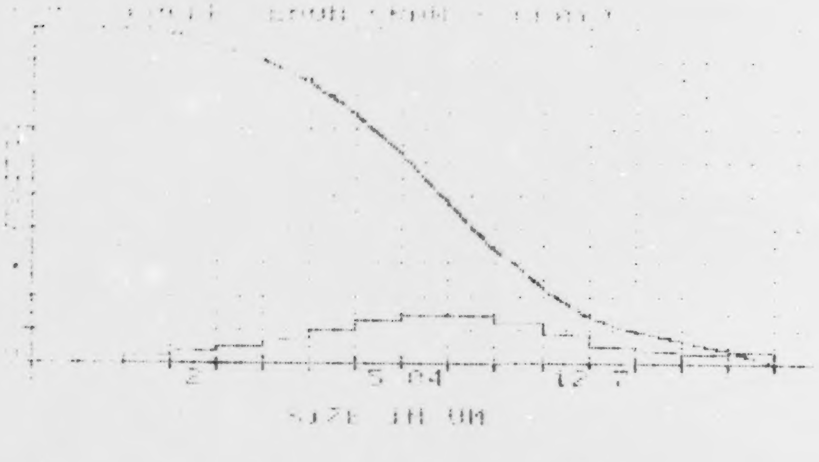
MEAN:                    2.5 UM
MEDIAN:                  2.25 UM
MODE                     1.9 UM
STANDARD DEVIATION:      1.48 UM
COEF. VAR.:              59.18%
SKEWNESS:                1.1 POSITIVE
KURTOSIS:                1.17 PLATYKURTIC
```



```
DATE. 25 MAY 1984
SAMPLE: ZENON (RAW - CLAY)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURES: 70
OPERATOR: MFH
COMMENTS: CALCULATED DIFFERENCE
*****************************************
CH.#    SIZE             DIFF        CUM
                         VOL %       VOL %
*****************************************
1       1                0           100
2       1.26             0           100
3       1.59             1.8         100
4       2                3.[illegible]         98.[illegible]
5       2.52             4.5         94.[illegible]
6       3.17             6.3         90.4
7       4                9.[illegible]         83.[illegible]
8       5.04             12.3        74.[illegible]
9       6.35             1[illegible].[illegible]        6[illegible]
10      8                14.[illegible]        47.[illegible]
11      10.08            11.[illegible]        33.[illegible]
12      12.7             8.1         2[illegible].[illegible]
13      16               4.4         1[illegible].[illegible]
14      20.16            3           [illegible]
15      25.4             1.[illegible]         [illegible]
16      3[illegible]            [illegible]         [illegible]

SAMPLE:ZENON (RAW - CLAY)IS.ZENON DIFF
*****************************************
        VOLUME % STATISTICS
*****************************************

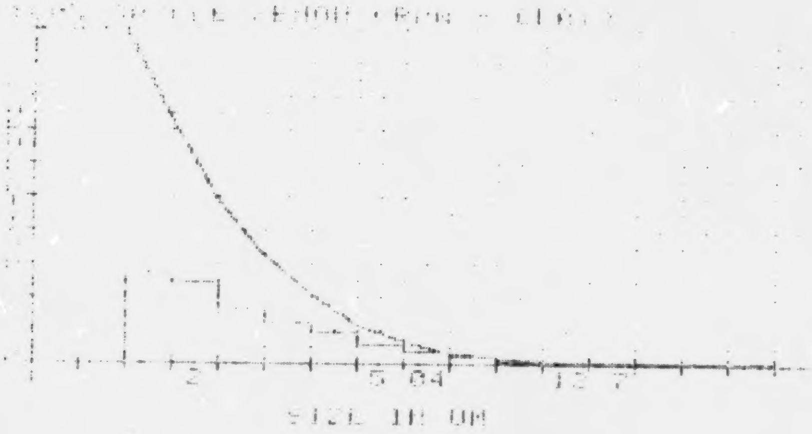
MEAN:                     7.81 UM
MEDIAN:                   7.73 UM
MODE                      8.14 UM
STANDARD DEVIATION:       1.97 UM
COEF. VAR.:               25.24%
SKEWNESS:                 1.05 NEGATIVE
KURTOSIS:                 1.8 PLATYKURTIC
```



```
DATE: 25 MAY 1984
SAMPLE: ZENON (RAW - CLAY)
ELECTROLYTE: ISOTON
DISPERSANT: NIL
EQUIPMENT: TA II
APERTURTES: 70
OPERATOR: MPH
COMMENTS: CALCULATED DIFFERENCE
****************************************
CH.#   SIZE          DIFF       CUM
                     POP %      POP %
****************************************
1      1             0          100
2      1.26          0          100
3      1.59          26.91      100
4      2             24.38      73.09
5      2.52          16.42      48.71
6      3.17          12.02      32.29
7      4             8.81       20.27
8      5.04          5.6        11.46
9      6.35          3.22       5.86
10     8             1.63       2.64
11     10.08         .68        1.01
12     12.7          .23        .33
13     16            .06        .1
14     20.16         .02        .04
15     25.4          .01        .02
16     32            .01        .01


SAMPLE:ZENON (RAW - CLAY)ID:ZENON DIFF
****************************************
        POPULATION STATISTICS
****************************************

MEAN:                     2.6 UM
MEDIAN:                   2.49 UM
MODE                      1.76 UM
STANDARD DEVIATION:       1.35 UM
COEF. VAR.:               55.51%
SKEWNESS:                 1.1 POSITIVE
KURTOSIS:                 1.15 PLATYKURTIC
```



ORF

# INFRA RED SPECTROPHOTOMETRY

## Conditions

Instrument - Perkin Elmer 283

Analysis - KBr Plates

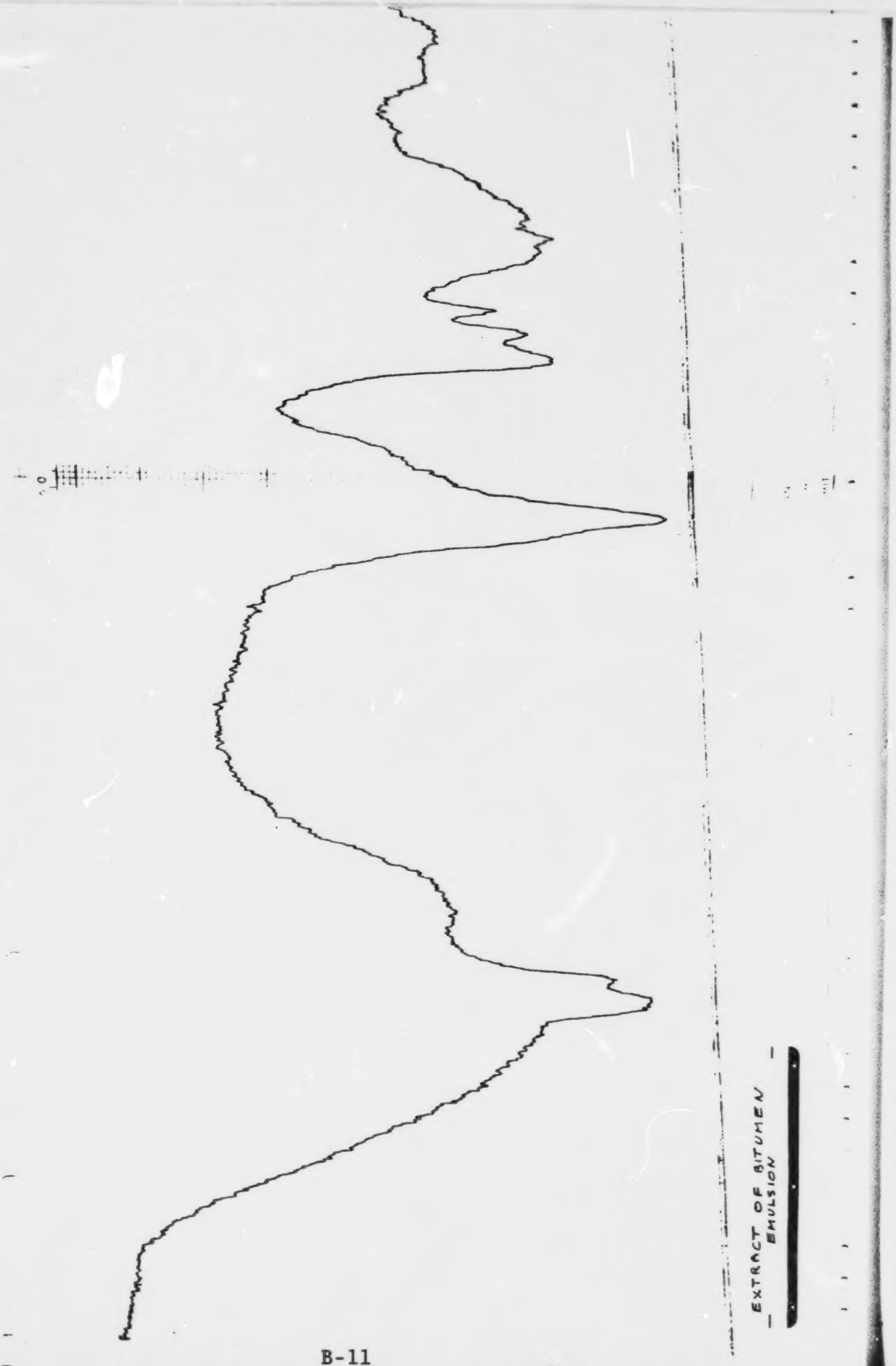
Mode - % Transfer

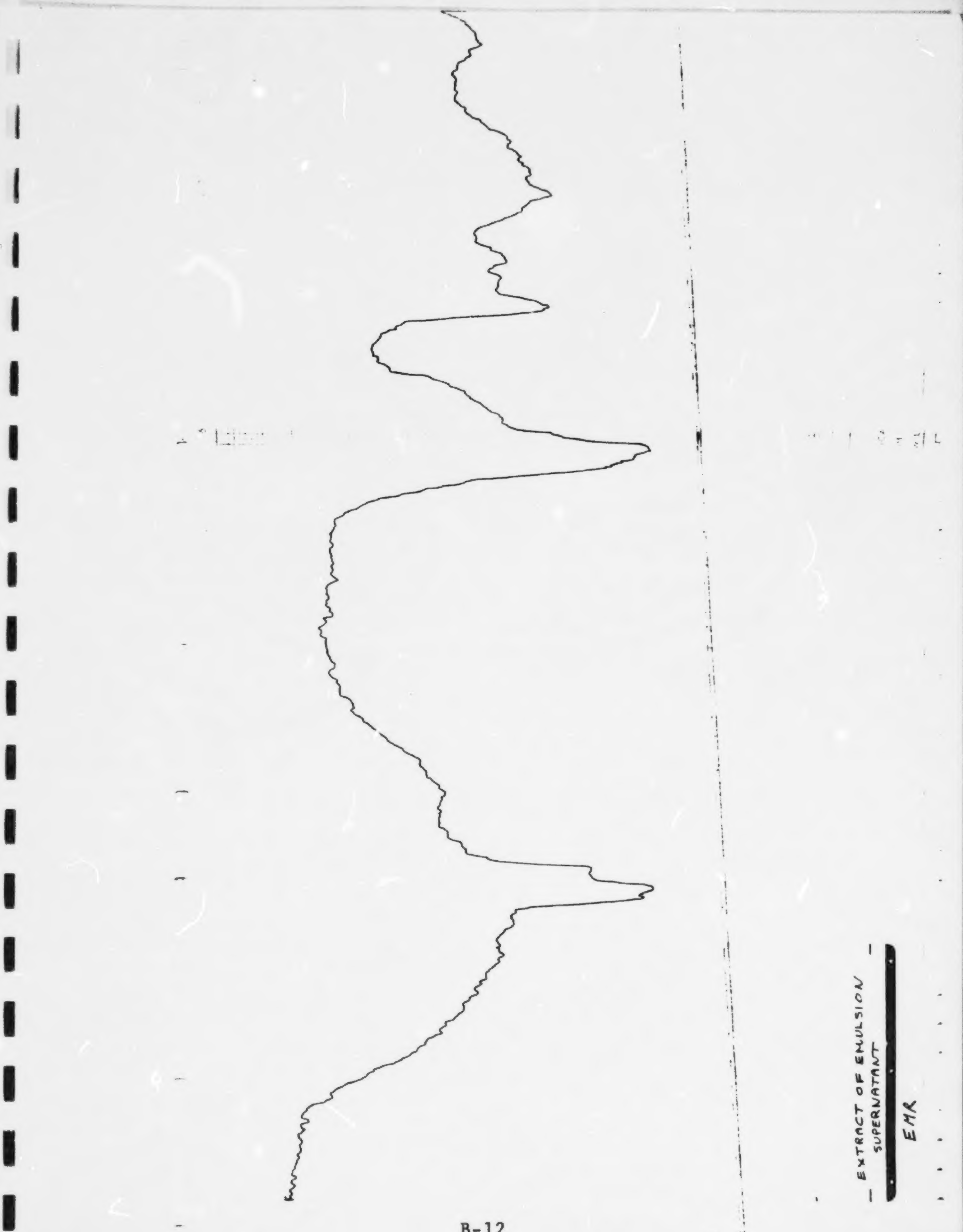
Scan - 4000 - 200 $CM^{-1}$

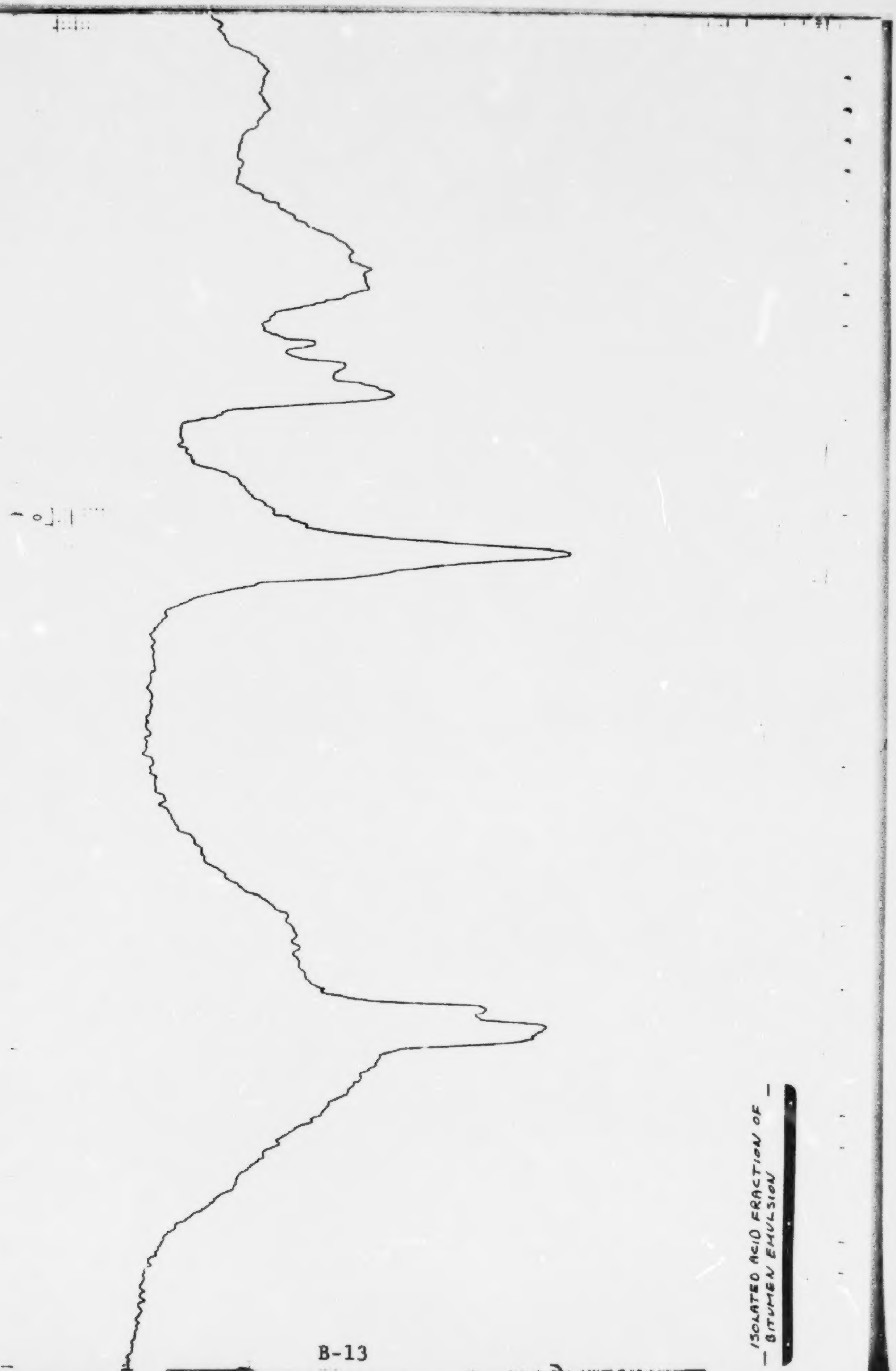
Scan Rate - 3 minutes

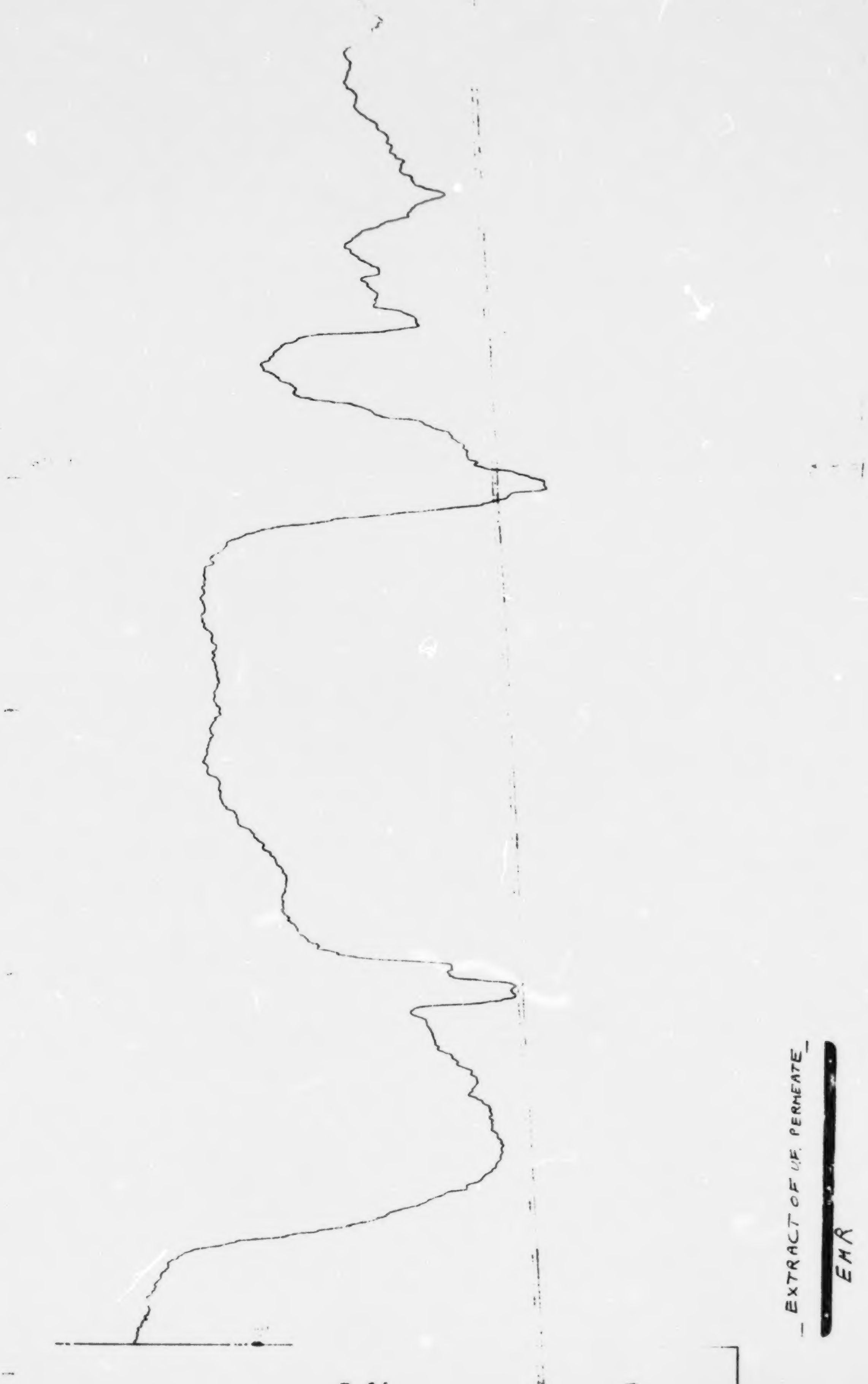
Calibration - Polystyrene

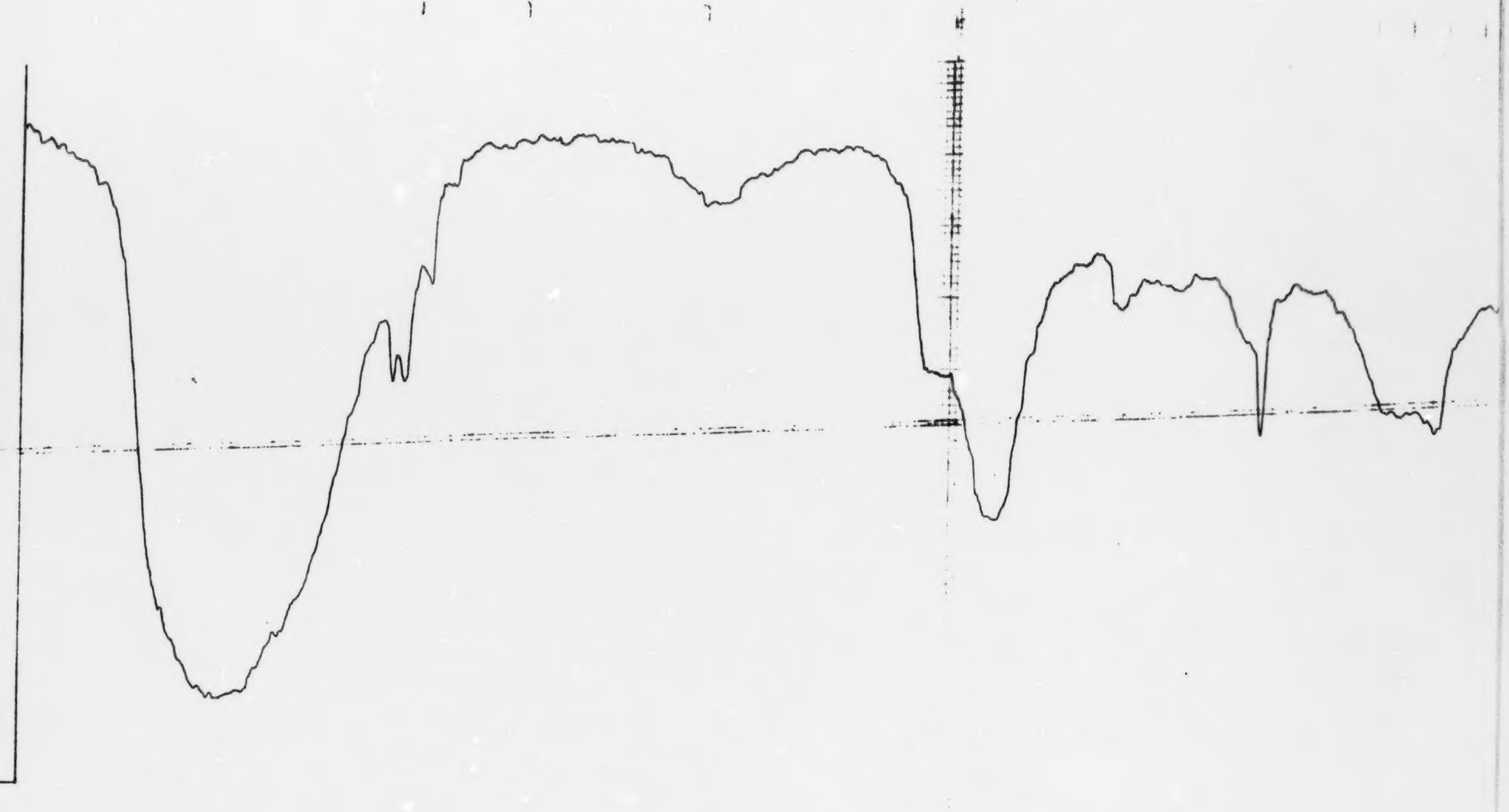
Results as follow


EXTRACT OF BITUMEN
EMULSION


EXTRACT OF EMULSION
SUPERNATANT
EMR


ISOLATED ACID FRACTION OF
BITUMEN EMULSION


EXTRACT OF U.F. PERMEATE
EMR



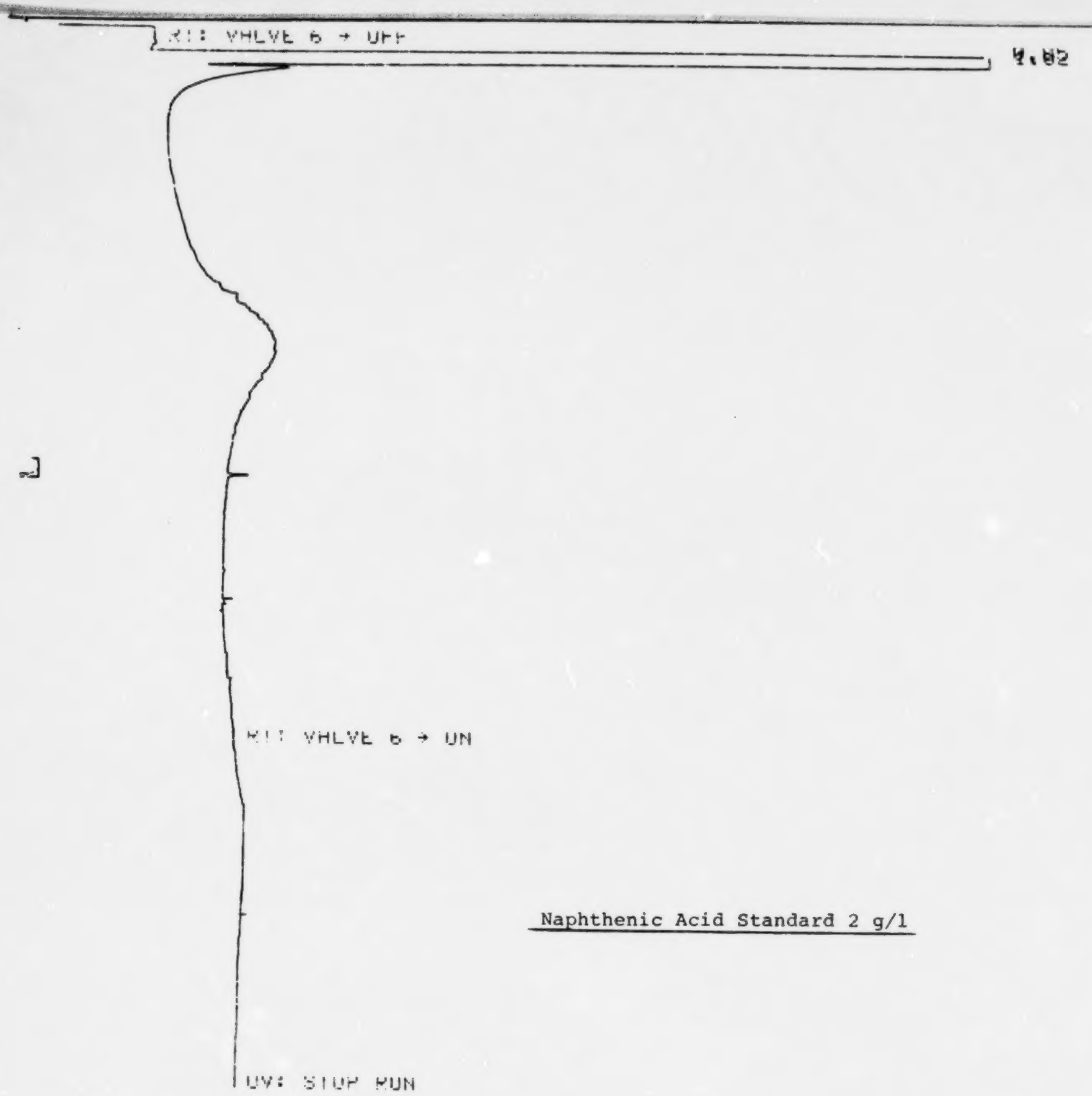
EXTRACT OF R.O. PERMEATE

## Gas Chromatograph Analysis

### Conditions

| | | |
|---|---|---|
| Instrument | - | HP5880-Level IV |
| Injection | - | Splitless, 30 sec. |
| Injector Temperature | - | 250°c |
| Split | - | 40 mL/min |
| Septum Flush | - | 6 mL/min |
| Column | - | 60 M X 0.31 mm ID DB-5 |
| Oven Temperature Profile | - | 60°c for 2 min, up to 220°c at 8°/min, then up to 270°c at 12°/min |
| Detection | - | Flame Ionization |
| Detector Air Flow | - | 450 mL/min |
| Detector Hydrogen Flow | - | 30 mL/min |
| Detector Makeup | - | Nitrogen @ 30 mL/min |

### Results as Follows



Naphthenic Acid Standard 2 g/l

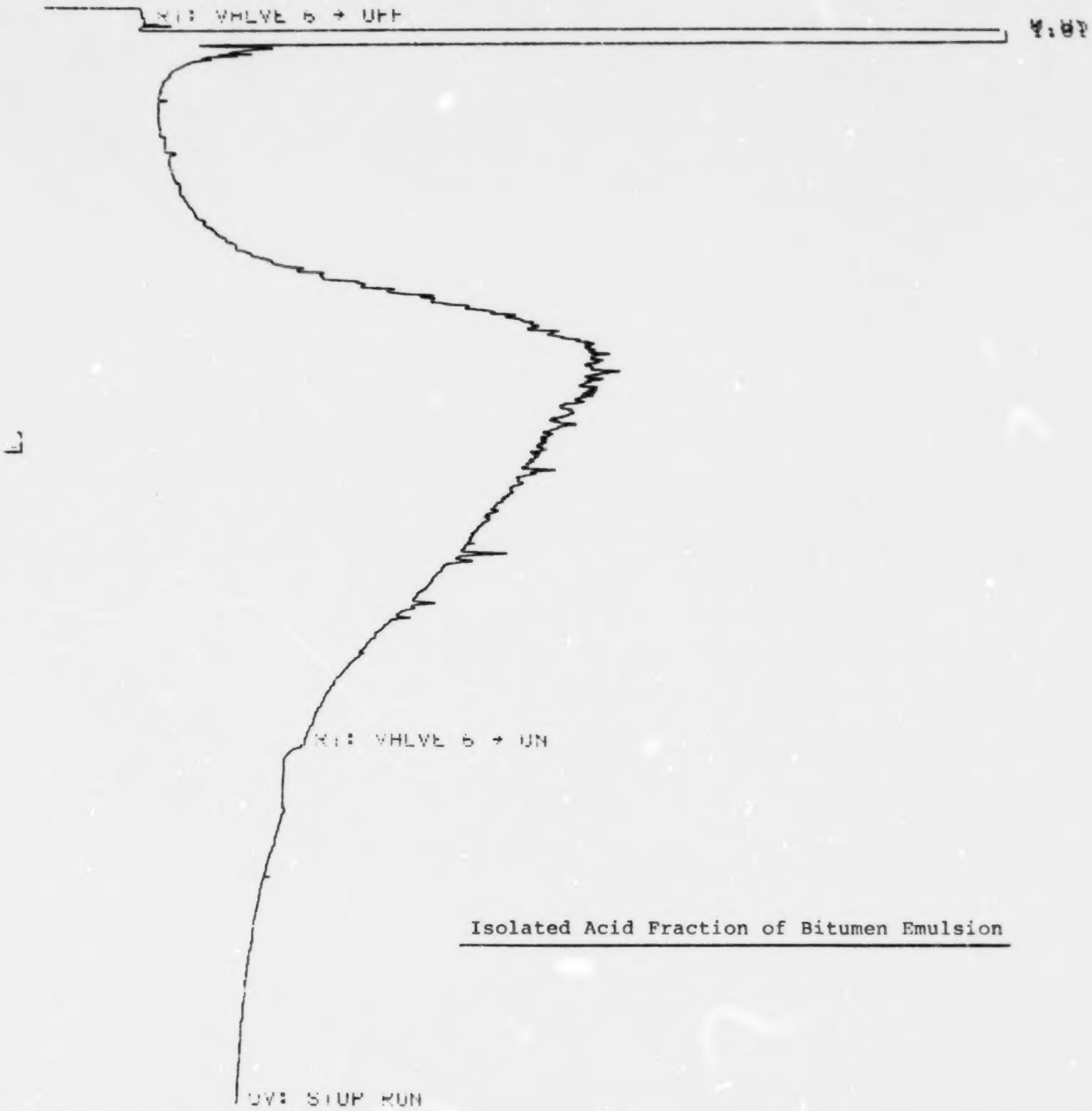
```
[HP] 5880A  SAMPLER INJECTION @ 17:21  NOV 28, 1984
  SAMPLE # :  ID CODE   :
        10   2MG/ML TSA  in MeCl2
AREA %

   RT                AREA  TYPE    AREA %

  0.85        491452.00   BH      99.512
  1.02          2409.54   HH       0.488

TOTAL AREA = 493861.00
MULTIPLIER = 1

VALVE 6 OFF
```



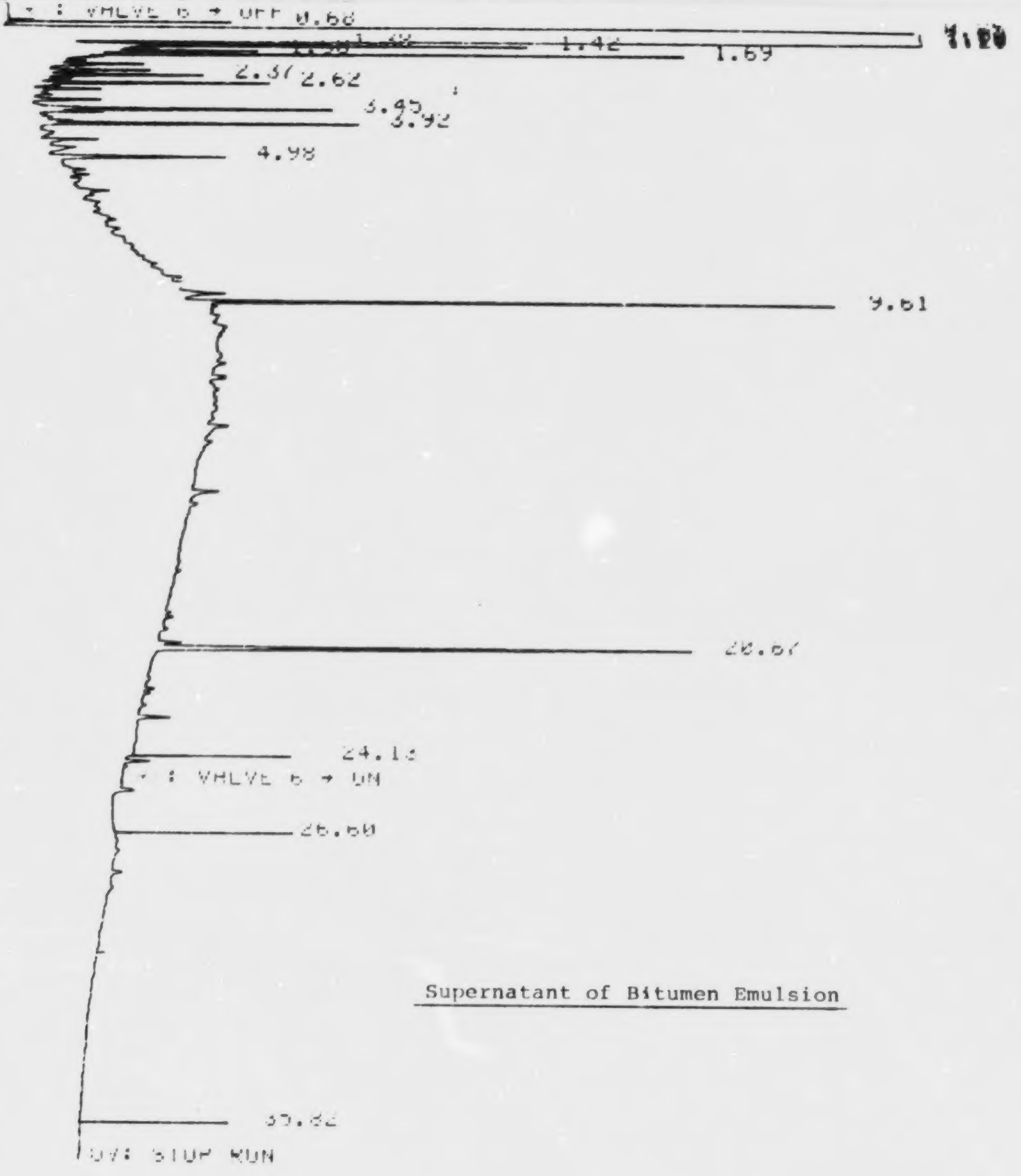
**Isolated Acid Fraction of Bitumen Emulsion**

```
[HP] 5880A  SAMPLER INJECTION @ 15:09  NOV 28, 1984
  SAMPLE # :  ID CODE   :
         9    BIT EMUL2
AREA %

   RT              AREA  TYPE    AREA %

  0.65        545132.00   BH     99.401
  1.01          3283.79   HH      0.599

TOTAL AREA = 548415.00
MULTIPLIER = 1
```

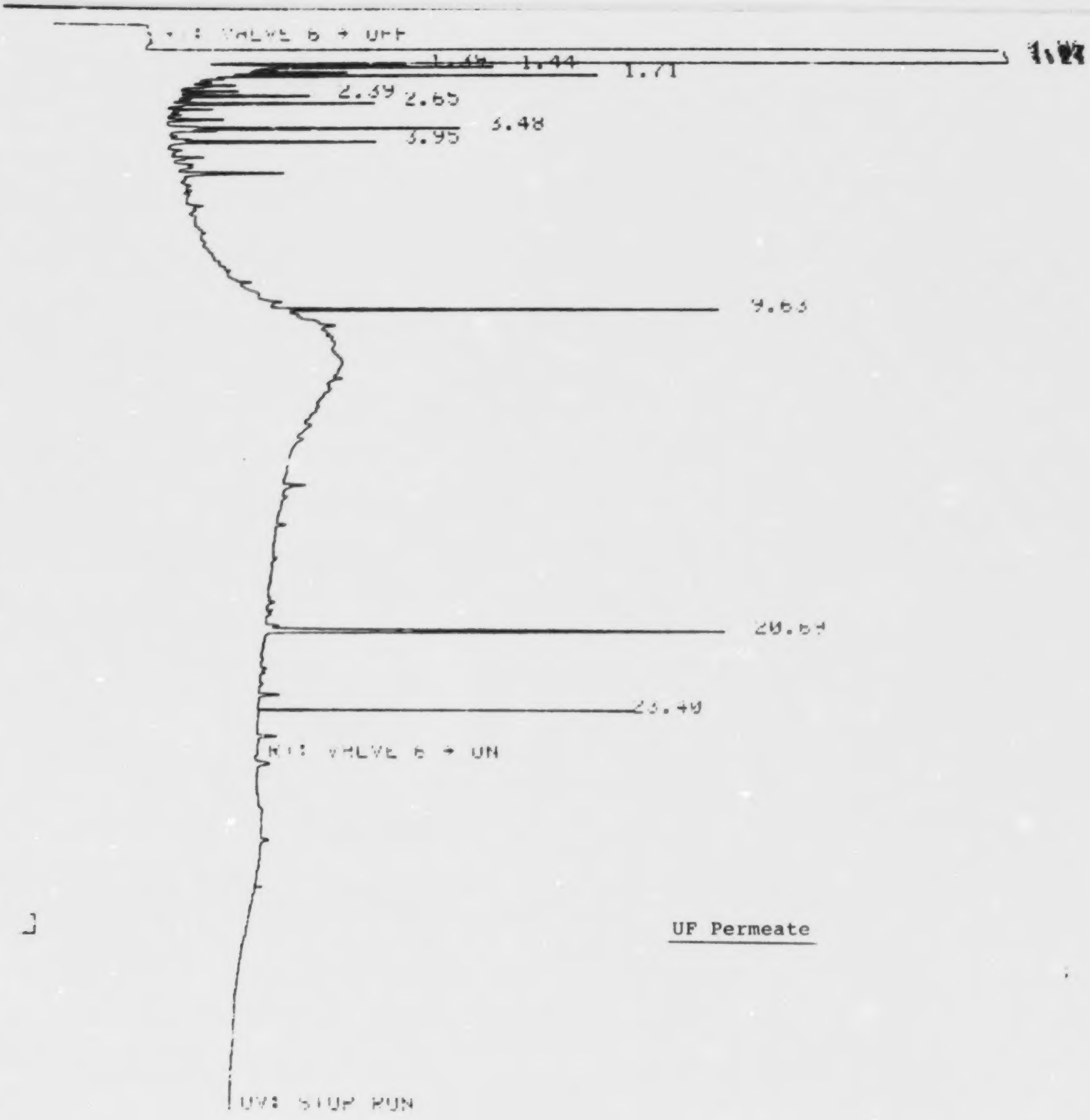


Supernatant of Bitumen Emulsion

```
[illegible] 5880A   SAMPLER INJECTION @ 14:26  NOV 28, 1984
   SAMPLE # :   ID CODE   :
          7     BIT SUPER
AREA %

    RT              AREA  TYPE     AREA %

   0.68             7.33   BP       0.001
   0.85        487222.00   BV      99.375
   1.01          2070.84   VV       0.422
   1.06           135.01   VV       0.028
   1.10            20.22   BP       0.004
   1.20           189.45   VP       0.039
   1.33            27.04   PV       0.006
   1.42            52.74   VV       0.011
   1.58            21.75   VV       0.004
   1.69            71.46   VV       0.015
   2.37            24.58   VV       0.005
   2.62            34.-    PV       0.007
   3.45            5        V       0.012
```

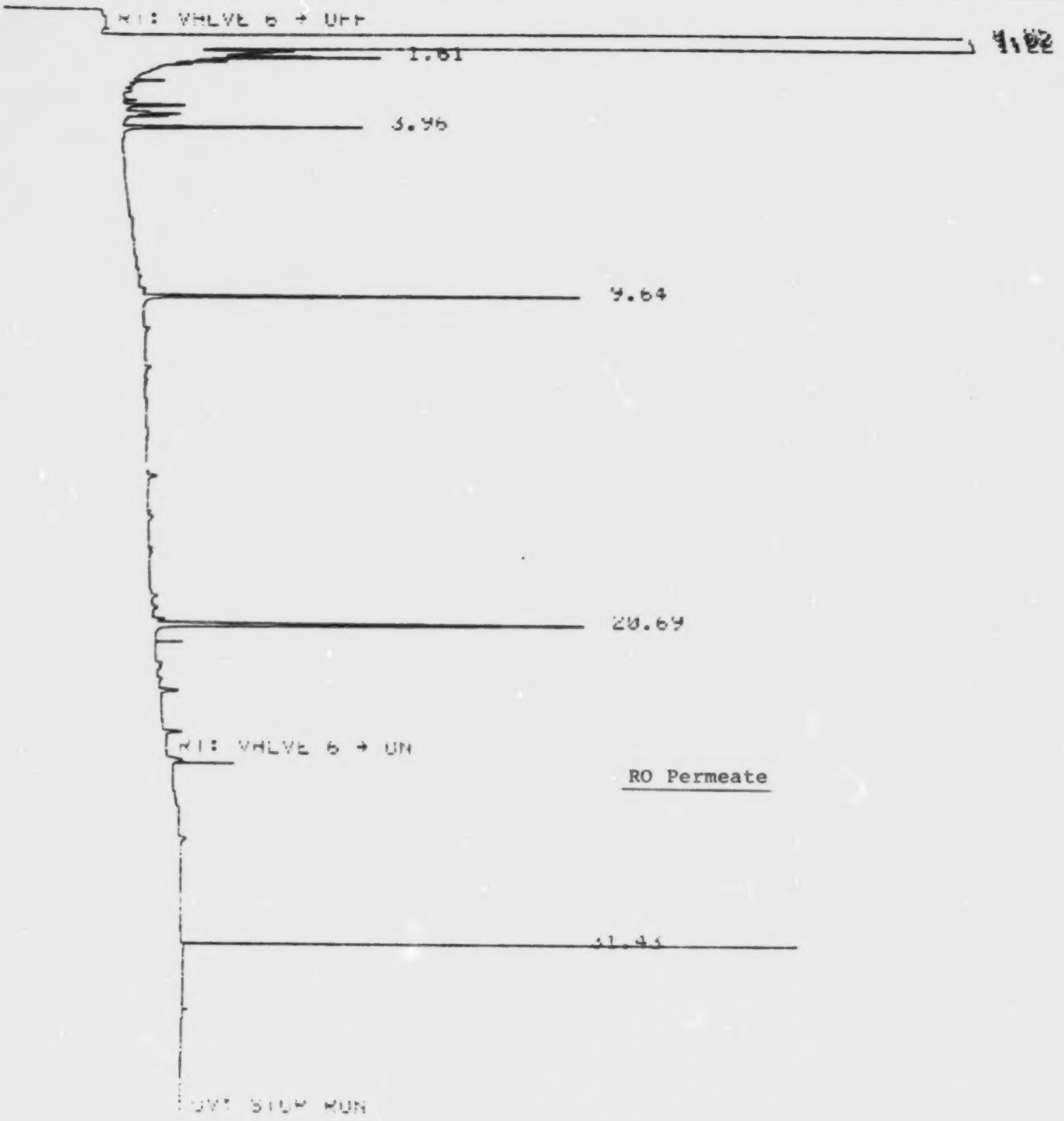


UF Permeate

```
RUN # [illegible]  SAMPLER INJECTION @ 13:42  NOV 28, 1984
  SAMPLE # :  ID CODE   :
         5       UF PERM
AREA %

   RT               AREA  TYPE    AREA %

   0.86        467628.00   BV     98.957
   1.02          2858.24   VV      0.605
   1.07           475.23   VV      0.101
   1.11           502.89   VV      0.106
   1.21           541.38   VV      0.115
   1.39            41.81   VV      0.009
   1.44            60.84   VV      0.013
   1.71            71.86   VV      0.015
   2.39            26.56   VV      0.006
   2.65            31.97   BV      0.007
   3.48            62.09   BV      0.013
   3.95            36.53   VB      0.008
```



RO Permeate

```
RUN # [illegible]   SAMPLER INJECTION @ 12:58  NOV 28, 1984
  SAMPLE # :  ID CODE   :
          5       RO PERM
AREA %

  RT              AREA  TYPE    AREA %

  0.85       558864.00   BV     98.009
  1.02         2904.56   VV      0.509
  1.07          989.25   VV      0.173
  1.22         7169.52   VV      1.257
  1.61           36.07   VV      0.006
  3.96           39.76   BB      0.007
  9.64           75.59   BB      0.013
 20.69          124.17   BB      0.022
 31.43           11.41   BB      0.002

TOTAL AREA = 570214.00
MULTIPLIER = 1
```

# APPENDIX C

## RESULTS OF PRESCREENING TESTS

## PURE WATER FLUX RATES

PRESSURE 100 psi TEMP 20 C

### CELLULOSE #12

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 9.0 | 0.60 | 0.76 |
| 31.0 | 5.6 | 0.35 | 0.44 |
| 46.0 | 4.0 | 0.27 | 0.34 |
| 61.5 | 5.1 | 0.33 | 0.41 |
| 76.5 | 4.9 | 0.33 | 0.41 |

### CELLULOSE ACETATE OK

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 40.5 | 2.70 | 3.40 |
| 30.0 | 40.0 | 2.67 | 3.36 |
| 45.0 | 40.0 | 2.67 | 3.36 |
| 60.0 | 39.5 | 2.63 | 3.32 |
| 75.0 | 40.0 | 2.67 | 3.36 |

### CELLULOSE #13

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 64.0 | 4.27 | 5.38 |
| 30.0 | 56.0 | 3.73 | 4.70 |
| 45.0 | 18.0 | 1.20 | 1.51 |
| 60.0 | 16.0 | 1.07 | 1.34 |

### CELLULOSE ACETATE 20K

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 71.5 | 4.77 | 6.01 |
| 30.0 | 72.0 | 4.80 | 6.05 |
| 45.0 | 72.0 | 4.80 | 6.05 |
| 60.0 | 72.0 | 4.80 | 6.05 |
| 75.0 | 72.0 | 4.80 | 6.05 |

### CELLULOSE #23

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 19.0 | 1.27 | 1.60 |
| 31.0 | 11.0 | 0.69 | 0.87 |
| 46.0 | 21.0 | 1.40 | 1.76 |
| 61.5 | 27.0 | 1.74 | 2.19 |
| 76.5 | 26.0 | 1.73 | 2.18 |

### CELLULOSE ACETATE 50K

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 19.5 | 1.30 | 1.64 |
| 30.0 | 21.5 | 1.43 | 1.81 |
| 45.5 | 22.0 | 1.42 | 1.79 |
| 61.0 | 21.0 | 1.35 | 1.71 |
| 76.0 | 20.0 | 1.33 | 1.68 |

### CELLULOSE RC-51

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 1.7 | 0.11 | 0.14 |
| 30.0 | 1.9 | 0.13 | 0.16 |
| 45.0 | 2.2 | 0.15 | 0.18 |
| 60.0 | 2.1 | 0.14 | 0.18 |
| 90.0 | 3.9 | 0.13 | 0.16 |
| 120.0 | 4.0 | 0.13 | 0.17 |

### CELLULOSE ACETATE CA-UF

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 17.0 | 1.13 | 1.43 |
| 30.0 | 16.8 | 1.12 | 1.41 |
| 45.0 | 16.8 | 1.12 | 1.41 |
| 60.0 | 16.8 | 1.12 | 1.41 |
| 75.0 | 16.4 | 1.09 | 1.38 |

## PURE WATER FLUX RATES
PRESSURE 100 psi TEMP 20 C

T.F.C. G5

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 3.9 | 0.26 | 0.33 |
| 30.0 | 3.9 | 0.26 | 0.33 |
| 45.0 | NA | 0.00 | 0.00 |
| 60.0 | 3.4 | 0.23 | 0.29 |
| 75.0 | 3.5 | 0.23 | 0.29 |

T.F.C. G10

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 30.0 | 28.5 | 0.95 | 1.20 |
| 60.0 | 29.5 | 0.98 | 1.24 |
| 75.0 | 15.5 | 1.03 | 1.30 |
| 90.0 | 15.0 | 1.00 | 1.26 |
| 105.0 | 14.5 | 0.97 | 1.22 |

T.F.C. G20

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 30.0 | 71.0 | 2.37 | 2.98 |
| 60.0 | 74.0 | 2.47 | 3.11 |
| 75.0 | 37.5 | 2.50 | 3.15 |
| 90.0 | 37.5 | 2.50 | 3.15 |
| 105.0 | 37.0 | 2.47 | 3.11 |

T.F.C. G50

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 10.0 | 94.5 | 9.45 | 11.91 |
| 25.0 | 133.5 | 8.90 | 11.21 |
| 40.0 | 132.4 | 8.83 | 11.12 |
| 55.0 | 131.5 | 8.77 | 11.05 |
| 70.0 | 131.0 | 8.73 | 11.00 |

POLYSULFONE OK

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 169.5 | 11.30 | 14.24 |
| 30.0 | 152.0 | 10.13 | 12.77 |
| 45.5 | 151.0 | 9.74 | 12.27 |
| 61.0 | 140.0 | 9.03 | 11.38 |
| 76.0 | 128.5 | 8.57 | 10.79 |

POLYSULFONE 20K

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 10.0 | 142.5 | 14.25 | 17.96 |
| 20.0 | 138.0 | 13.80 | 17.39 |
| 30.0 | 130.0 | 13.00 | 16.38 |
| 40.0 | 126.0 | 12.60 | 15.88 |
| 50.0 | 123.0 | 12.30 | 15.50 |

POLYSULFONE 50K

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 10.0 | 132.0 | 13.20 | 16.63 |
| 20.0 | 123.5 | 12.35 | 15.56 |
| 30.0 | 119.0 | 11.90 | 14.99 |
| 40.0 | 114.0 | 11.40 | 14.36 |
| 50.0 | 112.0 | 11.20 | 14.11 |

POLYSULFONE E500

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 231.0 | 15.40 | 19.40 |
| 30.0 | 214.0 | 14.27 | 17.98 |
| 45.5 | 190.5 | 12.29 | 15.49 |
| 60.0 | 173.5 | 11.97 | 15.08 |
| 75.0 | 171.0 | 11.40 | 14.36 |

PURE WATER FLUX RATES
PRESSURE 100 psi TEMP 20 C

C.H.P. Cat

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 10.0 | 205.0 | 20.50 | 25.83 |
| 25.0 | 270.0 | 18.00 | 22.68 |
| 40.0 | 228.0 | 15.20 | 19.15 |
| 55.0 | 175.0 | 11.67 | 14.70 |
| 70.0 | 180.0 | 12.00 | 15.12 |

C.H.P. B2

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 10.0 | 98.0 | 9.80 | 12.35 |
| 25.0 | 150.0 | 10.00 | 12.60 |
| 40.0 | 142.0 | 9.47 | 11.93 |
| 55.0 | 115.0 | 7.67 | 9.66 |
| 70.0 | 119.0 | 7.93 | 10.00 |

C.H.P. B3

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 183.0 | 12.20 | 15.37 |
| 30.0 | 154.0 | 10.27 | 12.94 |
| 45.0 | 154.0 | 10.27 | 12.94 |
| 60.0 | 147.0 | 9.80 | 12.35 |
| 75.0 | 143.0 | 9.53 | 12.01 |

POLYVINYLDIFLUORIDE

| TIME | MLS | MLS/MIN | M3/M2/D |
|---|---|---|---|
| 15.0 | 82.0 | 5.47 | 6.89 |
| 30.0 | 76.0 | 5.07 | 6.38 |
| 45.0 | 70.0 | 4.67 | 5.88 |
| 60.0 | 64.0 | 4.27 | 5.38 |
| 90.0 | 119.0 | 3.97 | 5.00 |
| 120.0 | 114.0 | 3.80 | 4.79 |

MEMBRANE SCREENING DATA
SALT WATER FLUX DATA OPERATING PRESSURE 100 psi
BRACKISH WATER TEMPERATURE 20 C

| | | | | FLUX | CONDUCTIVITY | | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| PS-0K | 10.0 | 116.0 | 11.60 | 14.62 | 2049 | 2200 | 6.86 |
| | 21.5 | 130.0 | 11.30 | 14.24 | 2050 | 2200 | 6.82 |
| | 31.5 | 111.0 | 11.10 | 13.99 | 2030 | 2200 | 7.73 |

| | | | | FLUX | CONDUCTIVITY | | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| PS-20K | 10.0 | 118.0 | 11.80 | 14.87 | 1990 | 2200 | 9.55 |
| | 21.5 | 131.0 | 11.39 | 14.35 | 1980 | 2200 | 10.00 |
| | 31.5 | 112.0 | 11.20 | 14.11 | 1990 | 2200 | 9.55 |

| | | | | FLUX | CONDUCTIVITY | | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| PS-50K | 15.5 | 212.0 | 13.68 | 17.23 | 1960 | 2200 | 10.91 |
| | 30.5 | 194.0 | 12.93 | 16.30 | 1910 | 2200 | 13.18 |
| | 45.5 | 188.0 | 12.53 | 15.79 | 1950 | 2200 | 11.36 |

| | | | | FLUX | CONDUCTIVITY | | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CELLULOSE | 30.0 | 3.9 | 0.13 | 0.16 | 1170 | 2500 | 53.20 |
| RC-51 | 60.0 | 3.9 | 0.13 | 0.16 | 2200 | 2475 | 11.11 |
| | 90.0 | 4.0 | 0.13 | 0.17 | 2325 | 2500 | 7.00 |
| | 120.0 | 4.0 | 0.13 | 0.17 | 2225 | 2500 | 11.00 |

| | | | | FLUX | CONDUCTIVITY | | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| PVDF | 30.0 | 114.0 | 3.80 | 4.79 | 2150 | 2500 | 14.00 |
| | 60.0 | 112.0 | 3.73 | 4.70 | 2275 | 2475 | 8.08 |
| | 90.0 | 108.0 | 3.60 | 4.54 | 2300 | 2500 | 8.00 |
| | 120.0 | 105.0 | 3.50 | 4.41 | 2250 | 2500 | 10.00 |

MEMBRANE SCREENING DATA
SALT WATER FLUX DATA  OPERATING PRESSURE 100 psi
BRACKISH WATER    TEMPERATURE 20C

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CA-UF | 15.0 | 136.0 | 9.07 | 11.42 | 2090 | 2300 | 9.13 |
| | 30.0 | 134.0 | 8.93 | 11.26 | 2070 | 2300 | 10.00 |
| | 45.0 | 133.0 | 8.87 | 11.17 | 2060 | 2290 | 10.04 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| PS-E500 | 15.5 | 180.0 | 11.61 | 14.63 | 2060 | 2410 | 14.52 |
| | 30.5 | 170.0 | 11.33 | 14.28 | 2080 | 2440 | 14.75 |
| | 45.5 | 145.0 | 9.67 | 12.18 | 2010 | 2300 | 12.61 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CELLULOSE 13 | 15.5 | 2.4 | 0.15 | 0.20 | 1960 | 2410 | 18.67 |
| | 30.5 | 2.4 | 0.16 | 0.20 | 1890 | 2440 | 22.54 |
| | 45.5 | 2.2 | 0.15 | 0.18 | 1950 | 2300 | 15.22 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CELLULOSE 12 | 15.0 | 4.9 | 0.32 | 0.41 | 2100 | 2250 | 6.67 |
| | 30.0 | 4.9 | 0.32 | 0.41 | 2180 | 2250 | 3.11 |
| | 45.0 | 4.7 | 0.31 | 0.39 | 2160 | 2275 | 5.05 |
| | 60.0 | 4.8 | 0.32 | 0.40 | 2160 | 2280 | 5.26 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CELLULOSE 23 | 15.0 | 27.0 | 1.80 | 2.27 | 2100 | 2250 | 6.67 |
| | 30.0 | 19.0 | 1.27 | 1.60 | 2180 | 2250 | 3.11 |
| | 45.0 | 6.0 | 0.40 | 0.50 | 2160 | 2275 | 5.05 |
| | 60.0 | 6.0 | 0.40 | 0.50 | 2160 | 2280 | 5.26 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| C.H.P. Cat | 15.0 | 191.0 | 12.73 | 16.04 | 1740 | 2300 | 24.35 |
| | 30.0 | 183.0 | 12.20 | 15.37 | 1730 | 2300 | 24.78 |
| | 45.0 | 177.0 | 11.80 | 14.87 | 1720 | 2300 | 25.22 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| C.H.P. B2 | 15.0 | 139.0 | 9.27 | 11.68 | 1625 | 2300 | 29.35 |
| | 30.0 | 138.0 | 9.20 | 11.59 | 1610 | 2300 | 30.00 |
| | 45.0 | 136.0 | 9.07 | 11.42 | 1620 | 2300 | 29.57 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| C.H.P. B3 | 15.0 | 151.0 | 10.07 | 12.68 | 1700 | 2300 | 26.09 |
| | 30.0 | 149.0 | 9.93 | 12.52 | 1690 | 2300 | 26.52 |
| | 45.0 | 143.0 | 9.53 | 12.01 | 1675 | 2300 | 27.17 |

MEMBRANE SCREENING DATA
SALT WATER FLUX DATA
BRACKISH WATER      TEMPERATURE 20 C

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| TFC G5 | 30.0 | 6.6 | 0.22 | 0.28 | 649 | 2200 | 70.50 |
| | 60.0 | 6.7 | 0.22 | 0.28 | 632 | 2210 | 71.40 |
| | 90.0 | 6.7 | 0.22 | 0.28 | 610 | 2210 | 72.40 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| TFC G10 | 30.0 | 23.0 | 0.77 | 0.97 | 610 | 2200 | 72.27 |
| | 60.0 | 22.8 | 0.76 | 0.96 | 600 | 2210 | 72.85 |
| | 90.0 | 22.5 | 0.75 | 0.95 | 590 | 2210 | 73.30 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| TFC G20 | 30.0 | 64.5 | 2.15 | 2.71 | 1040 | 2100 | 50.48 |
| | 60.0 | 63.0 | 2.10 | 2.65 | 1095 | 2180 | 49.77 |
| | 90.0 | 63.5 | 2.12 | 2.67 | 1100 | 2240 | 50.89 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| TFC G50 | 30.0 | 26.0 | 0.87 | 1.09 | 482 | 2100 | 77.05 |
| | 60.0 | 24.0 | 0.80 | 1.01 | 672 | 2180 | 69.17 |
| | 90.0 | 23.5 | 0.78 | 0.99 | 632 | 2240 | 71.79 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CA-0K | 15.0 | 77.0 | 5.13 | 6.47 | 2150 | 2150 | 0.00 |
| | 30.0 | 76.5 | 5.10 | 6.43 | 2140 | 2200 | 2.73 |
| | 45.5 | 78.0 | 5.03 | 6.34 | 2050 | 2100 | 2.38 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CA-20K | 15.0 | 67.5 | 4.50 | 5.67 | 2150 | 2150 | 0.00 |
| | 30.0 | 68.0 | 4.53 | 5.71 | 2200 | 2200 | 0.00 |
| | 45.5 | 69.0 | 4.45 | 5.61 | 2100 | 2100 | 0.00 |

| | | | | FLUX | | CONDUCTIVITY | |
|---|---|---|---|---|---|---|---|
| MEMBRANE | TIME | ml | ml/min | M3/M2/D | PERM | FEED | % REJ |
| CA-50K | 15.5 | 19.8 | 1.28 | 1.61 | 1145 | 2240 | 48.88 |
| | 30.5 | 19.0 | 1.27 | 1.60 | 1145 | 2210 | 48.19 |
| | 45.5 | 19.0 | 1.27 | 1.60 | 1140 | 2220 | 48.65 |

## MEMBRANE PRESCREENING TEST DATA
TEMP18.5C pH 8.0 100 psi
FEED EMULSION (TDS 460 mg/L)

| MEMBRANE | TIME MIN | PERM MLS | PERM MLS/MIN | FLUX RATE M3/M2/DAY | FEED TOC mg/L | PERM TOC mg/L | PERC REJ TOC | PERM COND uHmos/cm | PERM pH | TDS mg/L |
|---|---|---|---|---|---|---|---|---|---|---|
| TFC G50 | 30 | 28.0 | 0.93 | 1.01 | 1450 | 22.0 | 98.48 | | | |
| | 60 | 26.5 | 0.88 | 0.95 | 1845 | 86.0 | 95.34 | | | |
| | 90 | 25.5 | 0.85 | 0.92 | 1655 | 22.0 | 98.67 | | | |
| | 120 | 24.5 | 0.82 | 0.88 | 1445 | 22.0 | 98.48 | 245 | 7.82 | 248 |
| | 150 | 23.8 | 0.79 | 0.86 | 1655 | 22.0 | 98.67 | | | |
| | 180 | 23.0 | 0.77 | 0.83 | 1655 | 18.0 | 98.91 | | | |
| | 210 | 22.0 | 0.73 | 0.79 | 1655 | 22.0 | 98.67 | | | |
| CA 0K | 30 | 92.0 | 3.07 | 3.31 | 1450 | 75.0 | 94.83 | | | |
| | 60 | 72.0 | 2.40 | 2.59 | 1845 | 8.0 | 99.57 | | | |
| | 90 | 52.0 | 1.73 | 1.87 | 1655 | 71.0 | 95.71 | | | |
| | 120 | 41.0 | 1.37 | 1.48 | 1445 | 65.0 | 95.50 | 760 | 8.11 | 352 |
| | 150 | 34.0 | 1.13 | 1.22 | 1655 | 67.0 | 95.95 | | | |
| | 180 | 29.0 | 0.97 | 1.04 | 1655 | 65.0 | 96.07 | | | |
| | 210 | 26.0 | 0.87 | 0.94 | 1655 | 73.0 | 95.59 | | | |
| TFC G10 | 30 | 18.0 | 0.60 | 0.65 | 1450 | 15.0 | 98.97 | | | |
| | 60 | 18.0 | 0.60 | 0.65 | 1845 | 11.0 | 99.40 | | | |
| | 90 | 17.8 | 0.59 | 0.64 | 1655 | 8.0 | 99.52 | | | |
| | 120 | 17.5 | 0.58 | 0.63 | 1445 | 9.0 | 99.38 | 245 | 7.82 | 248 |
| | 150 | 17.5 | 0.58 | 0.63 | 1655 | 9.5 | 99.43 | | | |
| | 180 | 17.5 | 0.58 | 0.63 | 1655 | 8.5 | 99.49 | | | |
| | 210 | 17.0 | 0.57 | 0.61 | 1655 | 13.5 | 99.18 | | | |
| TFC G20 | 30 | 34.0 | 1.13 | 1.22 | 1450 | 36.0 | 97.52 | | | |
| | 60 | 25.0 | 0.83 | 0.90 | 1845 | 38.0 | 97.94 | | | |
| | 90 | 21.7 | 0.72 | 0.78 | 1655 | 33.0 | 98.01 | | | |
| | 120 | 20.0 | 0.67 | 0.72 | 1445 | 33.0 | 97.72 | 460 | 7.6 | 196 |
| | 150 | 18.5 | 0.62 | 0.67 | 1655 | 29.0 | 98.25 | | | |
| | 180 | 17.0 | 0.57 | 0.61 | 1655 | 32.0 | 98.07 | | | |
| | 210 | 16.0 | 0.53 | 0.58 | 1655 | 32.0 | 98.07 | | | |
| CA 20K | 30 | 31.5 | 1.05 | 1.13 | 1450 | 121.0 | 91.66 | | | |
| | 60 | 19.0 | 0.63 | 0.68 | 1845 | 111.0 | 93.98 | | | |
| | 90 | 16.0 | 0.53 | 0.58 | 1655 | 103.0 | 93.78 | | | |
| | 120 | 14.0 | 0.47 | 0.50 | 1445 | 83.0 | 94.26 | 770 | 8.04 | 464 |
| | 150 | 13.0 | 0.43 | 0.47 | 1655 | 105.0 | 93.66 | | | |
| | 180 | 12.0 | 0.40 | 0.43 | 1655 | 96.0 | 94.20 | | | |
| | 210 | 11.0 | 0.37 | 0.40 | 1655 | 98.0 | 94.08 | | | |
| CA 50K | 30 | 20.0 | 0.67 | 0.72 | 1450 | 121.0 | 91.66 | | | |
| | 60 | 16.0 | 0.53 | 0.58 | 1845 | 111.0 | 93.98 | | | |
| | 90 | 14.0 | 0.47 | 0.50 | 1655 | 103.0 | 93.78 | | | |
| | 120 | 12.0 | 0.40 | 0.43 | 1445 | 83.0 | 94.26 | 435 | 7.92 | 108 |
| | 150 | 11.5 | 0.38 | 0.41 | 1655 | 105.0 | 93.66 | | | |
| | 180 | 10.0 | 0.33 | 0.36 | 1655 | 96.0 | 94.20 | | | |
| | 210 | 9.5 | 0.32 | 0.34 | 1655 | 98.0 | 94.08 | | | |

MEMBRANE PRESCREENING TEST DATA
TEMP 20C,pH 8.0,100 PSI
FEED EMULSION (TDS 700 mg/L)

RUN 2

| MEMBRANE | TIME MIN | PERM MLS | PERM MLS/MIN | FLUX RATE M3/M2/DAY | FEED TOC mg/L | PERM TOC mg/L | PERC REJ TOC | PERM COND uHmos/cm | PERM pH | TDS mg/L |
|---|---|---|---|---|---|---|---|---|---|---|
| ZENON CHP Cat | 30 | 59.0 | 1.97 | 2.12 | 2255 | 44.0 | 98.05 | | | |
| | 60 | 44.0 | 1.47 | 1.58 | 2195 | 64.5 | 97.06 | | | |
| | 90 | 35.0 | 1.17 | 1.26 | 2191 | 42.0 | 98.08 | | | |
| | 120 | 33.0 | 1.10 | 1.19 | 1881 | 49.0 | 97.40 | 535 | 7.96 | NA |
| | 150 | 34.0 | 1.13 | 1.22 | 1793 | 54.0 | 96.99 | | | |
| | 180 | 28.9 | 0.96 | 1.04 | 1342 | 40.0 | 97.02 | | | |
| | 210 | 25.5 | 0.85 | 0.92 | 1609 | 36.0 | 97.76 | | | |
| ZENON CHP B3 | 30 | 92.0 | 3.07 | 3.31 | 2255 | 42.0 | 98.14 | | | |
| | 60 | 56.5 | 1.88 | 2.03 | 2195 | 60.0 | 97.27 | | | |
| | 90 | 40.9 | 1.36 | 1.47 | 2191 | 45.0 | 97.95 | | | |
| | 120 | 36.5 | 1.22 | 1.31 | 1881 | 45.0 | 97.61 | 520 | 8.01 | 312 |
| | 150 | 30.0 | 1.00 | 1.08 | 1793 | 37.0 | 97.94 | | | |
| | 180 | 21.0 | 0.70 | 0.76 | 1342 | 45.0 | 96.65 | | | |
| | 210 | 15.5 | 0.52 | 0.56 | 1609 | 36.0 | 97.76 | | | |
| ZENON CHP B2 | 30 | 66.0 | 2.20 | 2.38 | 2255 | 57.0 | 97.47 | | | |
| | 60 | 34.0 | 1.13 | 1.22 | 2195 | 82.0 | 96.26 | | | |
| | 90 | 28.0 | 0.93 | 1.01 | 2191 | 44.0 | 97.99 | | | |
| | 120 | 24.5 | 0.82 | 0.88 | 1881 | 33.0 | 98.25 | 525 | 7.96 | 192 |
| | 150 | 21.8 | 0.73 | 0.78 | 1793 | 51.0 | 97.16 | | | |
| | 180 | 18.0 | 0.60 | 0.65 | 1342 | 36.0 | 97.32 | | | |
| | 210 | 14.8 | 0.49 | 0.53 | 1609 | 36.0 | 97.76 | | | |
| PS E500 | 30 | 124.0 | 4.13 | 4.46 | 2255 | 73.0 | 96.76 | | | |
| | 60 | 59.0 | 1.97 | 2.12 | 2195 | 61.0 | 97.22 | | | |
| | 90 | 34.0 | 1.13 | 1.22 | 2191 | 56.0 | 97.44 | | | |
| | 120 | 34.0 | 1.13 | 1.22 | 1881 | 61.0 | 96.76 | 695 | 8.07 | 316 |
| | 150 | 29.0 | 0.97 | 1.04 | 1793 | 53.0 | 97.04 | | | |
| | 180 | 18.0 | 0.60 | 0.65 | 1342 | 55.0 | 95.90 | | | |
| | 210 | 13.0 | 0.43 | 0.47 | 1609 | 54.0 | 96.64 | | | |
| PS 20K | 30 | 41.0 | 1.37 | 1.48 | 2255 | 135.0 | 94.01 | | | |
| | 60 | 24.0 | 0.80 | 0.86 | 2195 | 109.0 | 95.03 | | | |
| | 90 | 20.0 | 0.67 | 0.72 | 2191 | 117.0 | 94.66 | | | |
| | 120 | 21.0 | 0.70 | 0.76 | 1881 | 108.0 | 94.26 | 800 | 8.11 | 564 |
| | 150 | 24.5 | 0.82 | 0.88 | 1793 | 113.0 | 93.70 | | | |
| | 180 | 21.0 | 0.70 | 0.76 | 1342 | 86.0 | 93.59 | | | |
| | 210 | 18.8 | 0.63 | 0.68 | 1609 | 79.0 | 95.09 | | | |
| PS 50K | 30 | 206.0 | 6.87 | 7.42 | 2255 | 56.0 | 97.52 | | | |
| | 60 | 110.0 | 3.67 | 3.96 | 2195 | 59.0 | 97.31 | | | |
| | 90 | 74.0 | 2.47 | 2.66 | 2191 | 65.0 | 97.03 | | | |
| | 120 | 69.0 | 2.30 | 2.48 | 1881 | 54.0 | 97.13 | 700 | 8 | 444 |
| | 150 | 56.0 | 1.87 | 2.02 | 1793 | 59.0 | 96.71 | | | |
| | 180 | 30.0 | 1.00 | 1.08 | 1342 | 56.0 | 95.83 | | | |
| | 210 | 21.0 | 0.70 | 0.76 | 1609 | 55.0 | 96.58 | | | |

MEMBRANE PRESCREENING TEST DATA
TEMP 20C,pH 8.0,100 psi
FEED EMULSION (TDS 780 mg/L)

| RUN 3 MEMBRANE | TIME MIN | PERM MLS | PERM MLS/MIN | FLUX RATE M3/M2/DAY | FEED TOC mg/L | PERM TOC mg/L | PERC REJ TOC | PERM COND uHmos/cm | PERM pH | TDS mg/L |
|---|---|---|---|---|---|---|---|---|---|---|
| CELLULOSE 12 | 30 | 7.5 | 0.25 | 0.27 | 2255 | 292.0 | 87.05 | | | |
| | 60 | 6.0 | 0.20 | 0.22 | 2195 | 188.0 | 91.44 | | | |
| | 90 | 4.8 | 0.16 | 0.17 | 2191 | 159.0 | 92.74 | | | |
| | 120 | 4.5 | 0.15 | 0.16 | 1881 | 132.0 | 92.98 | 700 | 8.28 | NA |
| | 150 | 4.0 | 0.13 | 0.14 | 1793 | 131.0 | 92.69 | | | |
| | 180 | 3.0 | 0.10 | 0.11 | 1342 | 102.0 | 92.40 | | | |
| | 210 | 3.0 | 0.10 | 0.11 | 1609 | 110.0 | 93.16 | | | |
| CELLULOSE 13 | 30 | 3.5 | 0.12 | 0.13 | 2255 | 585.0 | 74.06 | | | |
| | 60 | 3.0 | 0.10 | 0.11 | 2195 | 323.0 | 85.28 | | | |
| | 90 | 2.5 | 0.08 | 0.09 | 2191 | 176.0 | 91.97 | | | |
| | 120 | 2.8 | 0.09 | 0.10 | 1881 | 132.0 | 92.98 | NA | NA | NA |
| | 150 | 2.5 | 0.08 | 0.09 | 1793 | 101.0 | 94.37 | | | |
| | 180 | 2.5 | 0.08 | 0.09 | 1342 | 145.0 | 89.20 | | | |
| | 210 | 2.5 | 0.08 | 0.09 | 1609 | 154.0 | 90.43 | | | |
| CELLULOSE 23 | 30 | 16.0 | 0.53 | 0.58 | 2255 | 204.0 | 90.95 | | | |
| | 60 | 13.3 | 0.44 | 0.48 | 2195 | 86.0 | 96.08 | | | |
| | 90 | 12.8 | 0.43 | 0.46 | 2191 | 74.0 | 96.62 | | | |
| | 120 | 12.5 | 0.42 | 0.45 | 1881 | 80.0 | 95.75 | 695 | 8.05 | 332 |
| | 150 | 12.0 | 0.40 | 0.43 | 1793 | 74.0 | 95.87 | | | |
| | 180 | 10.5 | 0.35 | 0.38 | 1342 | 69.0 | 94.86 | | | |
| | 210 | 10.5 | 0.35 | 0.38 | 1609 | 109.0 | 93.23 | | | |

## MEMBRANE PORE SIZE EVALUATION
## POLYETHYLENE GLYCOL 6000 M.W.
## SCREENING TEST

AVERAGE FEED CONC. TOC 220 mg/L

### CELLULOSE

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 3.0 | 0.20 | 0.22 | 48.5 | 77.95 |
| 30 | 3.5 | 0.23 | 0.25 | 10.0 | 95.45 |
| 60 | 5.5 | 0.18 | 0.20 | 18.0 | 91.82 |

### POLYVINYLDIFLUORIDE

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 156.0 | 10.40 | 11.23 | 320.0 | 0.00 |
| 30 | 93.0 | 6.20 | 6.70 | 210.0 | 4.55 |
| 60 | 140.0 | 4.67 | 5.04 | 180.0 | 18.18 |

### THIN FILM COMPOSITE

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 10.00 | 0.67 | 0.72 | 40.0 | 81.82 |
| 30 | 9.00 | 0.60 | 0.65 | 40.5 | 81.59 |
| 60 | 14.50 | 0.48 | 0.52 | 39.0 | 82.27 |

### POLYSULFONE

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 475.00 | 31.67 | 34.20 | 230.0 | 0.00 |
| 30 | 350.00 | 23.33 | 25.20 | 210.0 | 4.55 |
| 60 | 509.00 | 16.97 | 18.32 | 180.0 | 18.18 |

### CELLULOSE ACETATE

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 120.00 | 8.00 | 8.64 | 270.0 | 0.00 |
| 30 | 109.00 | 7.27 | 7.85 | NA | 0.00 |
| 60 | 194.00 | 6.47 | 6.98 | 200.0 | 9.09 |

### CHP

| TIME IN (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE M3/M2 D | TOC mg/L | % REJ TOC |
|---|---|---|---|---|---|
| 15 | 149.50 | 9.97 | 10.76 | 200.0 | 9.09 |
| 30 | 138.00 | 9.20 | 9.94 | 150.0 | 31.82 |
| 60 | 240.00 | 8.00 | 8.64 | 220.0 | 0.00 |

# APPENDIX D

# RESULTS OF SCREENING TESTS

# FLUX RATES FOR EMULSION SCREENING TEST NO. 1

Temp.=25°C pH = as is (7.5 - 8.0) Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 75.00 | 0.54 | 0.96 | 1.92 | 1.71 | 1.81 | 1.04 | 0.27 |
| 90.00 | 1.05 | 0.91 | 1.77 | 1.63 | 1.62 | 1.08 | 0.26 |
| 105.00 | 1.56 | 0.91 | 1.77 | 1.55 | 1.58 | 1.08 | 0.26 |
| 120.00 | 2.03 | 0.86 | 1.63 | 1.42 | 1.43 | 1.04 | 0.26 |
| 150.00 | 2.93 | 0.93 | 1.51 | 1.34 | 1.33 | 1.03 | 0.26 |
| 180.00 | 3.80 | 0.91 | 1.44 | 1.26 | 1.25 | 1.04 | 0.26 |
| 210.00 | 4.62 | 0.86 | 1.36 | 1.16 | 1.16 | 1.01 | 0.26 |
| 244.00 | 5.51 | 0.84 | 1.29 | 1.09 | 1.09 | 1.00 | 0.26 |
| 300.00 | 6.74 | 0.80 | 1.06 | 0.90 | 0.89 | 0.81 | 0.22 |
| 360.00 | 7.88 | 0.66 | 0.91 | 0.78 | 0.78 | 0.72 | 0.20 |
| 420.00 | 9.08 | 0.69 | 0.93 | 0.79 | 0.80 | 0.78 | 0.22 |
| 480.00 | 10.23 | 0.66 | 0.89 | 0.75 | 0.76 | 0.77 | 0.23 |
| 540.00 | 11.36 | 0.66 | 0.86 | 0.74 | 0.74 | 0.77 | 0.23 |
| 600.00 | 12.47 | 0.63 | 0.84 | 0.71 | 0.71 | 0.76 | 0.23 |
| 660.00 | 13.56 | 0.61 | 0.84 | 0.68 | 0.71 | 0.77 | 0.24 |
| 720.00 | 14.58 | 0.57 | 0.77 | 0.65 | 0.65 | 0.70 | 0.23 |
| 780.00 | 15.60 | 0.59 | 0.77 | 0.65 | 0.65 | 0.70 | 0.23 |
| 1260.00 | 22.64 | 0.52 | 0.65 | 0.56 | 0.56 | 0.59 | 0.22 |
| 1320.00 | 23.45 | 0.44 | 0.60 | 0.51 | 0.51 | 0.55 | 0.22 |
| 1380.00 | 24.27 | 0.45 | 0.61 | 0.52 | 0.52 | 0.56 | 0.23 |
| 1440.00 | 25.07 | 0.45 | 0.61 | 0.50 | 0.52 | 0.52 | 0.22 |
| 1500.00 | 25.86 | 0.44 | 0.59 | 0.50 | 0.50 | 0.53 | 0.23 |

## ANALYTICAL DATA FOR SCREENING TEST NO.1

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH |  | 8.00 | 8.65 | 8.33 | 8.20 |  | 7.99 |  | 7.86 |  | 7.98 |  | 6.90 |  | 7.73 |  |
| COND | uHmos/cm | 975 | 1240 | 1108 | 960 | 13.3 | 518 | 53.2 | 385 | 65.2 | 358 | 67.7 | 221 | 80.0 | 478 | 56.8 |
| TURB | NTU | 930 | 1250 | 1090 | 0.98 | 99.9 | 0.42 | 100.0 | 0.45 | 100.0 | 0.49 | 100.0 | 0.41 | 100.0 | 0.42 | 100.0 |
| TOC | mg/L | 1940 | 1740 | 1840 | 79.0 | 95.7 | 59.5 | 96.8 | 57.5 | 96.9 | 49.0 | 97.3 | 11.0 | 99.4 | 53 | 97.1 |
| TDS | mg/L | 966 | 1333 | 1150 | 644 | 44.0 | 308 | 73.2 | 562 | 51.1 | 362 | 68.5 | 176 | 84.7 | 366 | 68.2 |
| HARDNESS | mg/L | 4.56 | NA | 4.56 | 0.62 | 86.4 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | 0.75 | 83.6 |
| DIS SIO2 | mg/L | 67.5 | NA | 67.5 | 46.2 | 31.6 | 49.2 | 27.1 | 47.0 | 30.4 | 47.7 | 29.3 | 43.0 | 36.3 | 44.9 | 33.5 |
| TSS | mg/L | 1413 | 1280 | 1347 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.1
% CUMULATIVE VOLUME REDUCTION
AUGUST 21 1984
VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 21.00 | 40.00 | 49.00 | 50.50 | 15.00 | 4.00 | 0.00 | | | 0.00 | 1.92 |
| 30.00 | 20.50 | 28.00 | 31.00 | 34.00 | 15.50 | 4.00 | 0.00 | | | 0.00 | 1.92 |
| 45.00 | 12.00 | 24.50 | 25.00 | 28.50 | 15.00 | 3.40 | 0.00 | | | 0.00 | 1.92 |
| 60.00 | 10.00 | 21.00 | 22.00 | 25.00 | 14.00 | 3.50 | 0.00 | | | 0.00 | 1.92 |
| 75.00 | 10.00 | 20.00 | 21.00 | 23.50 | 14.50 | 3.70 | 92.70 | 8.00 | 23.00 | 0.54 | 1.92 |
| 90.00 | 9.50 | 18.50 | 20.00 | 21.00 | 15.00 | 3.60 | 87.60 | | | 1.05 | 1.92 |
| 105.00 | 9.50 | 18.50 | 19.00 | 20.50 | 15.00 | 3.60 | 86.10 | | | 1.56 | 1.84 |
| 120.00 | 9.00 | 17.00 | 17.50 | 18.50 | 14.50 | 3.60 | 80.10 | | | 2.03 | 1.88 |
| 150.00 | 19.50 | 31.50 | 33.00 | 34.50 | 28.50 | 7.10 | 154.10 | | | 2.93 | 1.80 |
| 180.00 | 19.00 | 30.00 | 31.00 | 32.50 | 29.00 | 7.30 | 148.80 | | | 3.80 | 2.06 |
| 210.00 | 18.00 | 28.50 | 28.50 | 30.00 | 28.00 | 7.20 | 140.20 | | | 4.62 | 2.00 |
| 244.00 | 20.00 | 30.50 | 30.50 | 32.00 | 31.50 | 8.30 | 152.80 | | | 5.51 | 2.00 |
| 300.00 | 31.00 | 41.50 | 41.50 | 43.00 | 42.00 | 11.20 | 210.20 | | | 6.74 | 1.94 |
| 360.00 | 27.50 | 38.00 | 38.50 | 40.50 | 40.00 | 10.90 | 195.40 | | | 7.88 | 2.04 |
| 420.00 | 29.00 | 39.00 | 39.00 | 41.50 | 43.50 | 12.30 | 204.30 | | | 9.08 | 2.00 |
| 480.00 | 27.50 | 37.00 | 37.00 | 39.50 | 43.00 | 12.60 | 196.60 | | | 10.23 | 1.94 |
| 540.00 | 27.50 | 36.00 | 36.50 | 38.50 | 43.00 | 12.90 | 194.40 | | | 11.36 | 1.92 |
| 600.00 | 26.50 | 35.00 | 35.00 | 37.00 | 42.00 | 13.00 | 188.50 | | | 12.47 | 1.84 |
| 660.00 | 25.50 | 35.00 | 33.50 | 37.00 | 42.50 | 13.50 | 187.00 | | | 13.56 | 1.92 |
| 720.00 | 24.00 | 32.00 | 32.00 | 34.00 | 39.00 | 13.00 | 174.00 | | | 14.58 | 1.92 |
| 780.00 | 24.50 | 32.00 | 32.00 | 33.50 | 39.00 | 13.00 | 174.00 | | | 15.60 | 1.92 |
| 1260.00 | 173.00 | 218.00 | 219.00 | 233.00 | 263.00 | 99.00 | 1205.00 | | | 22.64 | 1.92 |
| 1320.00 | 18.50 | 25.00 | 25.00 | 26.50 | 30.50 | 12.00 | 137.50 | | | 23.45 | 1.92 |
| 1380.00 | 19.00 | 25.50 | 25.50 | 27.00 | 31.00 | 12.50 | 140.50 | | | 24.27 | 1.92 |
| 1440.00 | 19.00 | 25.50 | 24.50 | 27.00 | 29.00 | 12.00 | 137.00 | | | 25.07 | 1.92 |
| 1500.00 | 18.50 | 24.50 | 24.50 | 26.00 | 29.50 | 12.50 | 135.50 | 8.65 | 23.00 | 25.86 | 1.92 |

RUN NO. I
MEMBRANE: CHP
PRESSURE= 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 75.00 | 10.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 90.00 | 9.50 | 0.63 | 17.21 | 0.68 | 0.91 | |
| 105.00 | 9.50 | 0.63 | 17.21 | 0.68 | 0.91 | |
| 120.00 | 9.00 | 0.60 | 16.30 | 0.65 | 0.86 | 65.17 |
| 150.00 | 19.50 | 0.65 | 17.66 | 0.70 | 0.93 | |
| 180.00 | 19.00 | 0.63 | 17.21 | 0.68 | 0.91 | |
| 210.00 | 18.00 | 0.60 | 16.30 | 0.65 | 0.86 | |
| 244.00 | 20.00 | 0.59 | 15.98 | 0.64 | 0.84 | 70.79 |
| 300.00 | 31.00 | 0.55 | 15.04 | 0.60 | 0.80 | |
| 360.00 | 27.50 | 0.46 | 12.45 | 0.50 | 0.66 | 70.79 |
| 420.00 | 29.00 | 0.48 | 13.13 | 0.52 | 0.69 | |
| 480.00 | 27.50 | 0.46 | 12.45 | 0.50 | 0.66 | 70.79 |
| 540.00 | 27.50 | 0.46 | 12.45 | 0.50 | 0.66 | |
| 600.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.63 | 69.39 |
| 660.00 | 25.50 | 0.43 | 11.55 | 0.46 | 0.61 | |
| 720.00 | 24.00 | 0.40 | 10.87 | 0.43 | 0.57 | 65.17 |
| 780.00 | 24.50 | 0.41 | 11.09 | 0.44 | 0.59 | |
| 1260.00 | 173.00 | 0.36 | 9.79 | 0.39 | 0.52 | |
| 1320.00 | 18.50 | 0.31 | 8.38 | 0.33 | 0.44 | |
| 1380.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.45 | 70.79 |
| 1440.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.45 | |
| 1500.00 | 18.50 | 0.31 | 8.38 | 0.33 | 0.44 | 67.98 |

RUN NO. I
MEMBRANE: PVDF
PRESSURE= 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 133.50 | | | | | |
| 75.00 | 21.00 | 1.40 | 38.04 | 1.51 | 1.71 | |
| 90.00 | 20.00 | 1.33 | 36.23 | 1.44 | 1.63 | |
| 105.00 | 19.00 | 1.27 | 34.42 | 1.37 | 1.55 | |
| 120.00 | 17.50 | 1.17 | 31.70 | 1.26 | 1.42 | 70.79 |
| 150.00 | 33.00 | 1.10 | 29.89 | 1.19 | 1.34 | |
| 180.00 | 31.00 | 1.03 | 24.91 | 1.12 | 1.26 | |
| 210.00 | 28.50 | 0.95 | 24.45 | 1.03 | 1.16 | |
| 244.00 | 30.50 | 0.90 | 22.64 | 0.97 | 1.09 | 70.79 |
| 300.00 | 41.50 | 0.74 | 21.74 | 0.80 | 0.90 | |
| 360.00 | 38.50 | 0.64 | 20.83 | 0.69 | 0.78 | 70.79 |
| 420.00 | 39.00 | 0.65 | 19.47 | 0.70 | 0.79 | |
| 480.00 | 37.00 | 0.62 | 18.57 | 0.67 | 0.75 | 73.60 |
| 540.00 | 36.50 | 0.61 | 16.53 | 0.66 | 0.74 | |
| 600.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.71 | 70.79 |
| 660.00 | 33.50 | 0.56 | 15.17 | 0.60 | 0.68 | |
| 720.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.65 | 70.79 |
| 780.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.65 | |
| 1260.00 | 219.00 | 0.46 | 12.40 | 0.49 | 0.56 | |
| 1320.00 | 25.00 | 0.42 | 11.32 | 0.45 | 0.51 | |
| 1380.00 | 25.50 | 0.43 | 11.55 | 0.46 | 0.52 | 70.79 |
| 1440.00 | 24.50 | 0.41 | 11.09 | 0.44 | 0.50 | |
| 1500.00 | 24.50 | 0.41 | 11.09 | 0.44 | 0.50 | 23.00 |

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                              RUN NO.  I
                              MEMBRANE: PS
                              PRESSURE=  100.00 psi
                              PRESSURE CORRECTION FACTOR 1.33
    TIME      PERMEATE PERMEATE   FLUX      FLUX   CORRECTED SURFACE
               VOLUME    RATE     RATE      RATE   FLUX RATE TENSION
    (MIN)      (MLS)  (MLS/MIN)(US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
     60.00    118.50
     75.00     20.00     1.33     36.23      1.44      1.92
     90.00     18.50     1.23     33.51      1.33      1.77
    105.00     18.50     1.23     33.51      1.33      1.77
    120.00     17.00     1.13     30.79      1.22      1.63      65.17
    150.00     31.50     1.05     28.53      1.13      1.51
    180.00     30.00     1.00     27.17      1.08      1.44
    210.00     28.50     0.95     25.81      1.03      1.36
    244.00     30.50     0.90     24.37      0.97      1.29      65.17
    300.00     41.50     0.74     20.13      0.80      1.06
    360.00     38.00     0.63     17.21      0.68      0.91      67.98
    420.00     39.00     0.65     17.66      0.70      0.93
    480.00     37.00     0.62     16.75      0.67      0.89      67.98
    540.00     36.00     0.60     16.30      0.65      0.86
    600.00     35.00     0.58     15.85      0.63      0.84      67.98
    660.00     35.00     0.58     15.85      0.63      0.84
    720.00     32.00     0.53     14.49      0.58      0.77      67.98
    780.00     32.00     0.53     14.49      0.58      0.77
   1260.00    218.00     0.45     12.34      0.49      0.65
   1320.00     25.00     0.42     11.32      0.45      0.60
   1380.00     25.50     0.43     11.55      0.46      0.61      70.79
   1440.00     25.50     0.43     11.55      0.46      0.61
   1500.00     24.50     0.41     11.09      0.44      0.59      67.98
                              RUN NO.  I
                              MEMBRANE: CA
                              PRESSURE=  140.00 psi
                              PRESSURE CORRECTION FACTOR 1.07
    TIME      PERMEATE PERMEATE   FLUX      FLUX   CORRECTED SURFACE
               VOLUME    RATE     RATE      RATE   FLUX RATE TENSION
    (MIN)      (MLS)  (MLS/MIN)(US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
     60.00    149.00
     75.00     23.50     1.57     42.57      1.69      1.81
     90.00     21.00     1.40     38.04      1.51      1.62
    105.00     20.50     1.37     37.13      1.48      1.58
    120.00     18.50     1.23     33.51      1.33      1.43      65.17
    150.00     34.50     1.15     31.25      1.24      1.33
    180.00     32.50     1.08     29.43      1.17      1.25
    210.00     30.00     1.00     27.17      1.08      1.16
    244.00     32.00     0.94     25.57      1.02      1.09      65.17
    300.00     43.00     0.77     20.86      0.83      0.89
    360.00     40.50     0.68     18.34      0.73      0.78      73.60
    420.00     41.50     0.69     18.79      0.75      0.80
    480.00     39.50     0.66     17.89      0.71      0.76      65.17
    540.00     38.50     0.64     17.43      0.69      0.74
    600.00     37.00     0.62     16.75      0.67      0.71      73.60
    660.00     37.00     0.62     16.75      0.67      0.71
    720.00     34.00     0.57     15.40      0.61      0.65      56.74
    780.00     33.50     0.56     15.17      0.60      0.65
   1260.00    233.00     0.49     13.19      0.52      0.56
   1320.00     26.50     0.44     12.00      0.48      0.51
   1380.00     27.00     0.45     12.23      0.49      0.52      70.79
   1440.00     27.00     0.45     12.23      0.49      0.52
   1500.00     26.00     0.43     11.77      0.47      0.50      62.36
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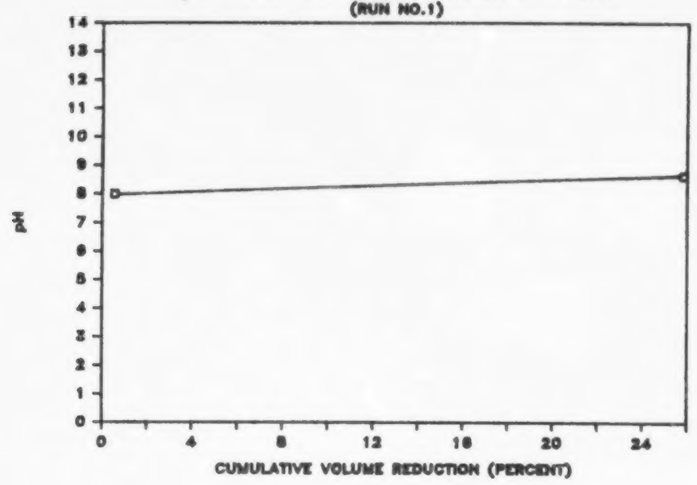
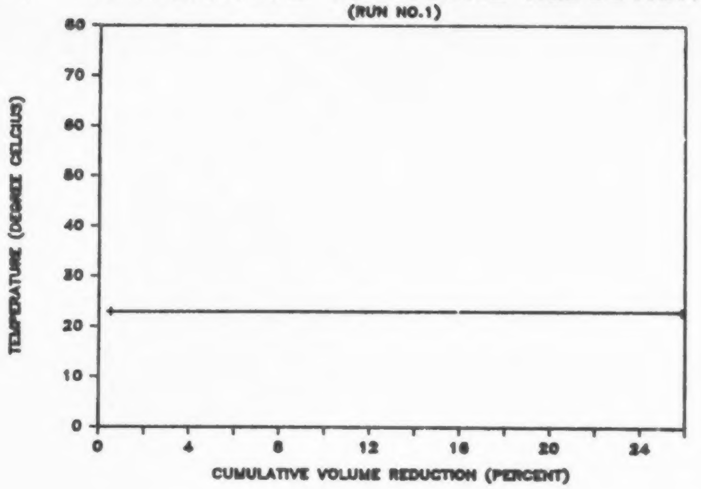
                    RUN NO.  I
                    MEMBRANE: TFC
                    PRESSURE=  150.00 psi
                    PRESSURE CORRECTION FACTOR 1.00
   TIME    PERMEATE PERMEATE   FLUX      FLUX    CORRECTED SURFACE
            VOLUME    RATE     RATE      RATE    FLUX RATE TENSION
  (MIN)     (MLS)  (MLS/MIN)(US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
   60.00    59.00
   75.00    14.50     0.97    26.26      1.04      1.04
   90.00    15.00     1.00    27.17      1.08      1.08
  105.00    15.00     1.00    27.17      1.08      1.08
  120.00    14.50     0.97    26.26      1.04      1.04     62.36
  150.00    28.50     0.95    25.81      1.03      1.03
  180.00    29.00     0.97    26.26      1.04      1.04
  210.00    28.00     0.93    25.36      1.01      1.01
  244.00    31.50     0.93    25.17      1.00      1.00     65.17
  300.00    42.00     0.75    20.38      0.81      0.81
  360.00    40.00     0.67    18.11      0.72      0.72     70.79
  420.00    43.50     0.73    19.70      0.78      0.78
  480.00    43.00     0.72    19.47      0.77      0.77     73.60
  540.00    43.00     0.72    19.47      0.77      0.77
  600.00    42.00     0.70    19.02      0.76      0.76     70.79
  660.00    42.50     0.71    19.25      0.77      0.77
  720.00    39.00     0.65    17.66      0.70      0.70     76.41
  780.00    39.00     0.65    17.66      0.70      0.70
 1260.00   263.00     0.55    14.89      0.59      0.59
 1320.00    30.50     0.51    13.81      0.55      0.55
 1380.00    31.00     0.52    14.04      0.56      0.56     70.79
 1440.00    29.00     0.48    13.13      0.52      0.52
 1500.00    29.50     0.49    13.36      0.53      0.53     56.74
                    RUN NO.  I
                    MEMBRANE: CELLULOSE
                    PRESSURE=  150.00 psi
                    PRESSURE CORRECTION FACTOR 1.00
   TIME    PERMEATE PERMEATE   FLUX      FLUX    CORRECTED SURFACE
            VOLUME    RATE     RATE      RATE    FLUX RATE TENSION
  (MIN)     (MLS)  (MLS/MIN)(US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
   60.00    17.00
   75.00     3.70     0.25     6.70      0.27      0.27
   90.00     3.60     0.24     6.52      0.26      0.26
  105.00     3.60     0.24     6.52      0.26      0.26
  120.00     3.60     0.24     6.52      0.26      0.26     67.98
  150.00     7.10     0.24     6.43      0.26      0.26
  180.00     7.30     0.24     6.61      0.26      0.26
  210.00     7.20     0.24     6.52      0.26      0.26
  244.00     8.30     0.24     6.63      0.26      0.26     67.98
  300.00    11.20     0.20     5.43      0.22      0.22
  360.00    10.90     0.18     4.94      0.20      0.20     73.60
  420.00    12.30     0.21     5.57      0.22      0.22
  480.00    12.60     0.21     5.71      0.23      0.23     67.98
  540.00    12.90     0.22     5.84      0.23      0.23
  600.00    13.00     0.22     5.89      0.23      0.23     67.98
  660.00    13.50     0.23     6.11      0.24      0.24
  720.00    13.00     0.22     5.89      0.23      0.23     67.98
  780.00    13.00     0.22     5.89      0.23      0.23
 1260.00    99.00     0.21     5.60      0.22      0.22
 1320.00    12.00     0.20     5.43      0.22      0.22
 1380.00    12.50     0.21     5.66      0.23      0.23     70.79
 1440.00    12.00     0.20     5.43      0.22      0.22
 1500.00    12.50     0.21     5.66      0.23      0.23     67.98
```

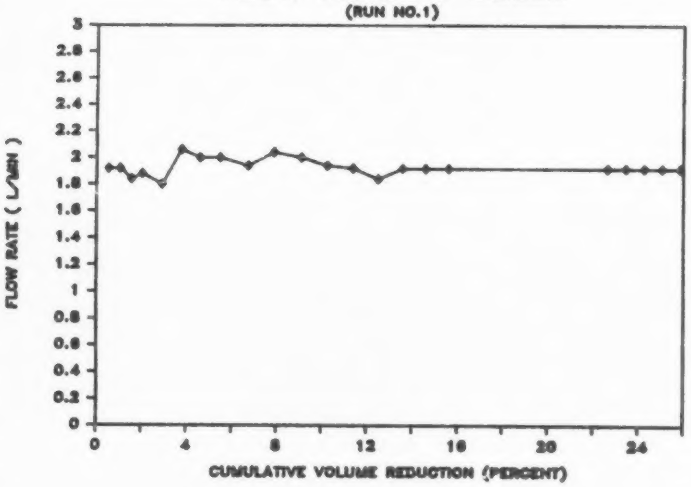
pH VS VOLUME REDUCTION
(RUN NO.1)



TEMPERATURE VS VOLUME REDUCTION
(RUN NO.1)



FLOW RATE TO CELLS
(RUN NO.1)



## FLUX RATES FOR EMULSION SCREENING TEST NO. 2

Temp. = 45°C pH = as is (7.5 - 8.0) Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 1.28 | 2.01 | 1.99 | 1.87 | 1.89 | 1.12 | 0.32 |
| 120.00 | 2.34 | 1.63 | 1.60 | 1.55 | 1.54 | 1.04 | 0.29 |
| 150.00 | 3.43 | 1.63 | 1.63 | 1.51 | 1.52 | 1.17 | 0.32 |
| 180.00 | 4.41 | 1.41 | 1.44 | 1.34 | 1.35 | 1.12 | 0.31 |
| 210.00 | 5.25 | 1.22 | 1.24 | 1.12 | 1.17 | 0.99 | 0.27 |
| 240.00 | 6.07 | 1.15 | 1.17 | 1.10 | 1.12 | 0.97 | 0.27 |
| 300.00 | 7.62 | 1.11 | 1.10 | 1.02 | 1.04 | 0.95 | 0.28 |
| 360.00 | 9.13 | 1.08 | 1.05 | 0.98 | 1.02 | 0.95 | 0.28 |
| 420.00 | 10.59 | 1.07 | 1.02 | 0.94 | 0.96 | 0.94 | 0.27 |
| 480.00 | 11.96 | 0.97 | 0.96 | 0.87 | 0.90 | 0.88 | 0.29 |
| 540.00 | 13.28 | 0.90 | 0.90 | 0.83 | 0.87 | 0.87 | 0.28 |
| 600.00 | 14.53 | 0.86 | 0.86 | 0.79 | 0.82 | 0.82 | 0.27 |
| 660.00 | 15.73 | 0.84 | 0.83 | 0.75 | 0.78 | 0.78 | 0.26 |
| 1380.00 | 27.96 | 0.70 | 0.68 | 0.63 | 0.66 | 0.68 | 0.24 |
| 1440.00 | 29.14 | 0.81 | 0.79 | 0.71 | 0.71 | 0.80 | 0.32 |
| 1500.00 | 29.97 | 0.54 | 0.55 | 0.52 | 0.53 | 0.58 | 0.23 |

ANALYTICAL DATA FOR SCREENING TEST NO.2

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 7.56 | 8.40 | 7.98 | 8.12 | | 7.86 | | 8.02 | | 7.82 | | 7.79 | | 7.73 | |
| COND | uHmos/cm | 900 | 1120 | 1010 | 850 | 15.8 | 470 | 53.5 | 485 | 52.0 | 470 | 53.5 | 195 | 80.7 | 420 | 58.4 |
| TURB | NTU | 1250 | 1400 | 1325 | 1.20 | 99.9 | 0.64 | 100.0 | 0.60 | 100.0 | 0.63 | 100.0 | 0.28 | 100.0 | 0.64 | 100.0 |
| TOC | mg/L | 2040 | 1990 | 2015 | 73.0 | 96.4 | 58.0 | 97.1 | 65.0 | 96.8 | 65.0 | 96.8 | 22.0 | 98.9 | 67.0 | 96.7 |
| TDS | mg/L | 980 | NA | 980 | 605 | 38.3 | 445 | 54.6 | 450 | 54.1 | 400 | 59.2 | 195 | 80.1 | 405 | 58.7 |
| HARDNESS | mg/L | 3.11 | NA | 3.11 | 1.37 | 55.9 | <0.15 | 100.0 | 8.74 | -181.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 |
| DIS SIO2 | mg/L | 69.6 | NA | 69.6 | 41.2 | 40.8 | 42.3 | 39.2 | 40.3 | 42.1 | 38.9 | 44.1 | 40.3 | 42.1 | 38.9 | 44.1 |
| TSS | mg/L | 1790 | NA | 1790 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO. 2
% CUMULATIVE VOLUME REDUCTION
AUGUST 23/84
VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 39.00 | 36.50 | 43.00 | 49.00 | 12.50 | 3.50 | 0.00 | | | 0.00 | 2.00 |
| 30.00 | 31.00 | 31.50 | 35.00 | 40.00 | 16.50 | 4.60 | 0.00 | | | 0.00 | 2.20 |
| 45.00 | 25.00 | 26.00 | 29.00 | 31.50 | 15.00 | 4.50 | 0.00 | | | 0.00 | 1.92 |
| 60.00 | 23.00 | 24.50 | 26.50 | 28.50 | 15.00 | 4.40 | 0.00 | | | 0.00 | 1.94 |
| 90.00 | 42.00 | 41.50 | 46.00 | 49.00 | 31.00 | 8.80 | 218.30 | 7.56 | 42.00 | 1.28 | 2.04 |
| 120.00 | 34.00 | 33.50 | 38.00 | 40.00 | 29.00 | 8.00 | 182.50 | | 45.00 | 2.34 | 1.92 |
| 150.00 | 34.00 | 34.00 | 37.00 | 39.50 | 32.50 | 8.80 | 185.80 | | 43.00 | 3.43 | 1.92 |
| 180.00 | 29.50 | 30.00 | 33.00 | 35.00 | 31.00 | 8.50 | 167.00 | | 45.00 | 4.41 | 1.84 |
| 210.00 | 25.50 | 26.00 | 27.50 | 30.50 | 27.50 | 7.60 | 144.60 | | 44.00 | 5.25 | 1.88 |
| 240.00 | 24.00 | 24.50 | 27.00 | 29.00 | 27.00 | 7.60 | 139.10 | | 43.00 | 6.07 | 1.80 |
| 300.00 | 46.50 | 46.00 | 50.00 | 54.00 | 53.00 | 15.50 | 265.00 | | 45.00 | 7.62 | 2.06 |
| 360.00 | 45.00 | 44.00 | 48.00 | 53.00 | 53.00 | 15.50 | 258.50 | | 46.00 | 9.13 | 2.00 |
| 420.00 | 44.50 | 42.50 | 46.00 | 50.00 | 52.00 | 15.20 | 250.20 | | 45.00 | 10.59 | 2.00 |
| 480.00 | 40.50 | 40.00 | 43.00 | 46.50 | 49.00 | 16.00 | 235.00 | | 44.00 | 11.96 | 1.94 |
| 540.00 | 37.50 | 37.50 | 41.00 | 45.00 | 48.50 | 15.70 | 225.20 | | 45.00 | 13.28 | 2.04 |
| 600.00 | 36.00 | 36.00 | 39.00 | 42.50 | 45.50 | 15.00 | 214.00 | | 44.00 | 14.53 | 2.00 |
| 660.00 | 35.00 | 34.50 | 37.00 | 40.50 | 43.50 | 14.50 | 205.00 | | 44.00 | 15.73 | 1.94 |
| 1380.00 | 353.00 | 340.00 | 370.00 | 410.00 | 455.00 | 163.00 | 2091.00 | | 52.00 | 27.96 | 1.92 |
| 1440.00 | 34.00 | 33.00 | 35.00 | 37.00 | 44.50 | 17.50 | 201.00 | | 46.00 | 29.14 | 1.84 |
| 1500.00 | 22.50 | 23.00 | 25.50 | 27.50 | 32.00 | 12.50 | 143.00 | 8.40 | 42.00 | 29.97 | 1.92 |

RUN NO. II
MEMBRANE: CHP
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 42.00 | 1.40 | 38.04 | 1.51 | 2.01 | 72.20 |
| 120.00 | 34.00 | 1.13 | 30.79 | 1.22 | 1.63 | |
| 150.00 | 34.00 | 1.13 | 30.79 | 1.22 | 1.63 | |
| 180.00 | 29.50 | 0.98 | 26.72 | 1.06 | 1.41 | 62.36 |
| 210.00 | 25.50 | 0.85 | 23.09 | 0.92 | 1.22 | |
| 240.00 | 24.00 | 0.80 | 21.74 | 0.86 | 1.15 | |
| 300.00 | 46.50 | 0.78 | 21.06 | 0.84 | 1.11 | 70.79 |
| 360.00 | 45.00 | 0.75 | 20.38 | 0.81 | 1.08 | |
| 420.00 | 44.50 | 0.74 | 20.15 | 0.80 | 1.07 | 69.39 |
| 480.00 | 40.50 | 0.68 | 18.34 | 0.73 | 0.97 | |
| 540.00 | 37.50 | 0.63 | 16.98 | 0.68 | 0.90 | 69.39 |
| 600.00 | 36.00 | 0.60 | 16.30 | 0.65 | 0.86 | |
| 660.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.84 | |
| 1380.00 | 353.00 | 0.49 | 13.32 | 0.53 | 0.70 | 69.39 |
| 1440.00 | 34.00 | 0.57 | 15.40 | 0.61 | 0.81 | 72.20 |
| 1500.00 | 22.50 | 0.38 | 10.19 | 0.41 | 0.54 | |

RUN NO. II
MEMBRANE: PVDF
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 46.00 | 1.53 | 41.66 | 1.66 | 1.87 | |
| 120.00 | 38.00 | 1.27 | 34.42 | 1.37 | 1.55 | |
| 150.00 | 37.00 | 1.23 | 33.51 | 1.33 | 1.51 | |
| 180.00 | 33.00 | 1.10 | 29.89 | 1.19 | 1.34 | 65.17 |
| 210.00 | 27.50 | 0.92 | 29.89 | 0.99 | 1.12 | |
| 240.00 | 27.00 | 0.90 | 24.91 | 0.97 | 1.10 | |
| 300.00 | 50.00 | 0.83 | 24.45 | 0.90 | 1.02 | 72.20 |
| 360.00 | 48.00 | 0.80 | 22.64 | 0.86 | 0.98 | |
| 420.00 | 46.00 | 0.77 | 21.74 | 0.83 | 0.94 | 70.79 |
| 480.00 | 43.00 | 0.72 | 20.83 | 0.77 | 0.87 | |
| 540.00 | 41.00 | 0.68 | 19.47 | 0.74 | 0.83 | 69.39 |
| 600.00 | 39.00 | 0.65 | 18.57 | 0.70 | 0.79 | |
| 660.00 | 37.00 | 0.62 | 16.75 | 0.67 | 0.75 | |
| 1380.00 | 370.00 | 0.51 | 13.96 | 0.56 | 0.63 | 72.20 |
| 1440.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.71 | 72.20 |
| 1500.00 | 25.50 | 0.43 | 11.55 | 0.46 | 0.52 | |

RUN NO. II
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME<br>(MIN) | PERMEATE VOLUME<br>(MLS) | PERMEATE RATE<br>(MLS/MIN) | FLUX RATE<br>(US GFD) | FLUX RATE<br>(M3/M2·D) | CORRECTED FLUX RATE<br>(M3/M2·D) | SURFACE TENSION<br>(DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 41.50 | 1.38 | 37.59 | 1.49 | 1.99 | 70.79 |
| 120.00 | 33.50 | 1.12 | 30.34 | 1.21 | 1.60 | |
| 150.00 | 34.00 | 1.13 | 30.79 | 1.22 | 1.63 | |
| 180.00 | 30.00 | 1.00 | 27.17 | 1.08 | 1.44 | 63.77 |
| 210.00 | 26.00 | 0.87 | 23.55 | 0.94 | 1.24 | |
| 240.00 | 24.50 | 0.82 | 22.19 | 0.88 | 1.17 | |
| 300.00 | 46.00 | 0.77 | 20.83 | 0.83 | 1.10 | 73.60 |
| 360.00 | 44.00 | 0.73 | 19.92 | 0.79 | 1.05 | |
| 420.00 | 42.50 | 0.71 | 19.25 | 0.77 | 1.02 | 73.60 |
| 480.00 | 40.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 540.00 | 37.50 | 0.63 | 16.98 | 0.68 | 0.90 | 70.79 |
| 600.00 | 36.00 | 0.60 | 16.30 | 0.65 | 0.86 | |
| 660.00 | 34.50 | 0.58 | 15.62 | 0.62 | 0.83 | |
| 1380.00 | 340.00 | 0.47 | 12.83 | 0.51 | 0.68 | 69.39 |
| 1440.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.79 | 70.79 |
| 1500.00 | 23.00 | 0.38 | 10.42 | 0.41 | 0.55 | |

RUN NO. II
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

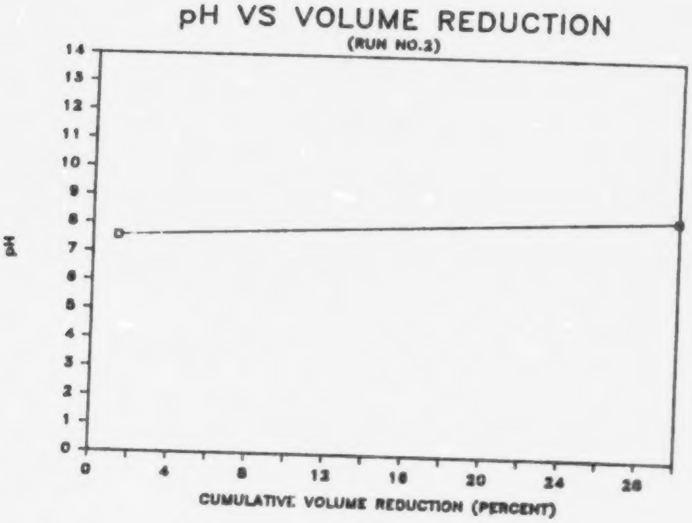
| TIME<br>(MIN) | PERMEATE VOLUME<br>(MLS) | PERMEATE RATE<br>(MLS/MIN) | FLUX RATE<br>(US GFD) | FLUX RATE<br>(M3/M2·D) | CORRECTED FLUX RATE<br>(M3/M2·D) | SURFACE TENSION<br>(DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 49.00 | 1.63 | 44.38 | 1.76 | 1.89 | 69.39 |
| 120.00 | 40.00 | 1.33 | 36.23 | 1.44 | 1.54 | |
| 150.00 | 39.50 | 1.32 | 35.77 | 1.42 | 1.52 | |
| 180.00 | 35.00 | 1.17 | 31.70 | 1.26 | 1.35 | 62.36 |
| 210.00 | 30.50 | 1.02 | 27.62 | 1.10 | 1.17 | |
| 240.00 | 29.00 | 0.97 | 26.26 | 1.04 | 1.12 | |
| 300.00 | 54.00 | 0.90 | 24.45 | 0.97 | 1.04 | 70.79 |
| 360.00 | 53.00 | 0.88 | 24.00 | 0.95 | 1.02 | |
| 420.00 | 50.00 | 0.83 | 22.64 | 0.90 | 0.96 | 73.60 |
| 480.00 | 46.50 | 0.78 | 21.06 | 0.84 | 0.90 | |
| 540.00 | 45.00 | 0.75 | 20.38 | 0.81 | 0.87 | 69.39 |
| 600.00 | 42.50 | 0.71 | 19.25 | 0.77 | 0.82 | |
| 660.00 | 40.50 | 0.68 | 18.34 | 0.73 | 0.78 | |
| 1380.00 | 410.00 | 0.57 | 15.47 | 0.62 | 0.66 | 69.39 |
| 1440.00 | 37.00 | 0.62 | 16.75 | 0.67 | 0.71 | 72.20 |
| 1500.00 | 27.50 | 0.46 | 12.45 | 0.50 | 0.53 | |

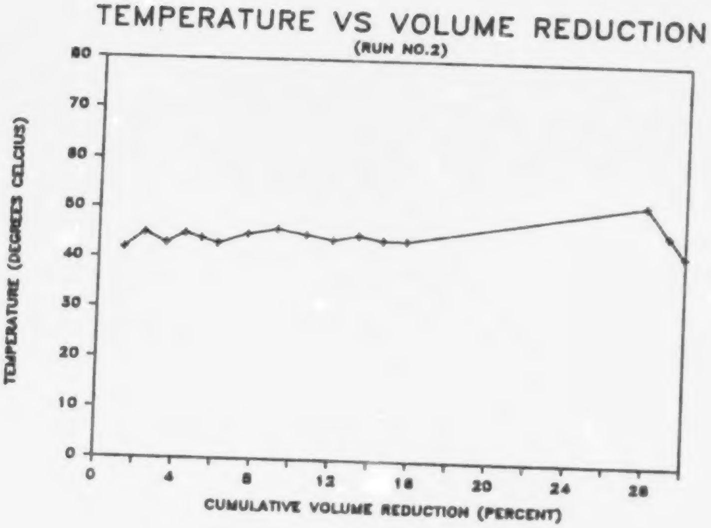
RUN NO. II
MEMBRANE: TFC
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

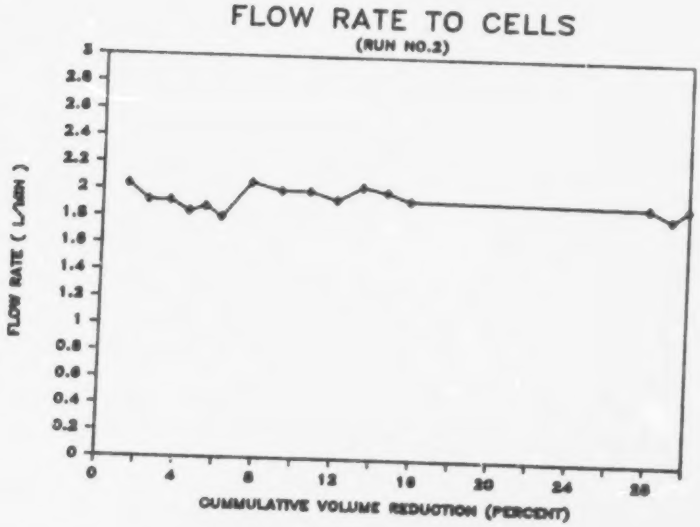
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 31.00 | 1.03 | 28.08 | 1.12 | 1.12 | 75.01 |
| 120.00 | 29.00 | 0.97 | 26.26 | 1.04 | 1.04 | |
| 150.00 | 32.50 | 1.08 | 29.43 | 1.17 | 1.17 | |
| 180.00 | 31.00 | 1.03 | 28.08 | 1.12 | 1.12 | 65.17 |
| 210.00 | 27.50 | 0.92 | 24.91 | 0.99 | 0.99 | |
| 240.00 | 27.00 | 0.90 | 24.45 | 0.97 | 0.97 | |
| 300.00 | 53.00 | 0.88 | 24.00 | 0.95 | 0.95 | 72.20 |
| 360.00 | 53.00 | 0.88 | 24.00 | 0.95 | 0.95 | |
| 420.00 | 52.00 | 0.87 | 23.55 | 0.94 | 0.94 | 70.79 |
| 480.00 | 49.00 | 0.82 | 22.19 | 0.88 | 0.88 | |
| 540.00 | 48.50 | 0.81 | 21.96 | 0.87 | 0.87 | 72.20 |
| 600.00 | 45.50 | 0.76 | 20.60 | 0.82 | 0.82 | |
| 660.00 | 43.50 | 0.73 | 19.70 | 0.78 | 0.78 | |
| 1380.00 | 455.00 | 0.63 | 17.17 | 0.68 | 0.68 | 70.79 |
| 1440.00 | 44.50 | 0.74 | 20.15 | 0.80 | 0.80 | 70.79 |
| 1500.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.58 | |

RUN NO. II
MEMBRANE: CELLULOSE
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 8.80 | 0.29 | 7.97 | 0.32 | 0.32 | 70.79 |
| 120.00 | 8.00 | 0.27 | 7.25 | 0.29 | 0.29 | |
| 150.00 | 8.80 | 0.29 | 7.97 | 0.32 | 0.32 | |
| 180.00 | 8.50 | 0.28 | 7.70 | 0.31 | 0.31 | 59.55 |
| 210.00 | 7.60 | 0.25 | 6.88 | 0.27 | 0.27 | |
| 240.00 | 7.60 | 0.25 | 6.88 | 0.27 | 0.27 | |
| 300.00 | 15.50 | 0.26 | 7.02 | 0.28 | 0.28 | 67.98 |
| 360.00 | 15.50 | 0.26 | 7.02 | 0.28 | 0.28 | |
| 420.00 | 15.20 | 0.25 | 6.88 | 0.27 | 0.27 | 70.79 |
| 480.00 | 16.00 | 0.27 | 7.25 | 0.29 | 0.29 | |
| 540.00 | 15.70 | 0.26 | 7.11 | 0.28 | 0.28 | 70.79 |
| 600.00 | 15.00 | 0.25 | 6.79 | 0.27 | 0.27 | |
| 660.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 1380.00 | 163.00 | 0.23 | 6.15 | 0.24 | 0.24 | 67.98 |
| 1440.00 | 17.50 | 0.29 | 7.92 | 0.32 | 0.32 | 67.98 |
| 1500.00 | 12.50 | 0.21 | 5.66 | 0.23 | 0.23 | |


pH VS VOLUME REDUCTION
(RUN NO.2)


TEMPERATURE VS VOLUME REDUCTION
(RUN NO.2)


FLOW RATE TO CELLS
(RUN NO.2)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 3

Temp. =25 °C pH = 5.5 Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 0.80 | 1.46 | 0.26 | 1.26 | 1.48 | 0.86 | 0.29 |
| 120.00 | 1.49 | 1.17 | 0.24 | 1.02 | 1.25 | 0.79 | 0.27 |
| 150.00 | 2.11 | 1.05 | 0.24 | 0.92 | 1.14 | 0.76 | 0.27 |
| 240.00 | 3.80 | 1.04 | 0.20 | 0.77 | 0.97 | 0.70 | 0.26 |
| 300.00 | 4.80 | 0.83 | 0.19 | 0.68 | 0.85 | 0.65 | 0.26 |
| 360.00 | 5.76 | 0.80 | 0.20 | 0.64 | 0.79 | 0.63 | 0.26 |
| 420.00 | 6.65 | 0.71 | 0.18 | 0.59 | 0.73 | 0.59 | 0.26 |
| 480.00 | 7.51 | 0.69 | 0.19 | 0.57 | 0.71 | 0.58 | 0.26 |
| 540.00 | 8.36 | 0.67 | 0.19 | 0.55 | 0.69 | 0.56 | 0.26 |
| 600.00 | 9.18 | 0.65 | 0.19 | 0.54 | 0.67 | 0.54 | 0.26 |
| 660.00 | 9.97 | 0.62 | 0.18 | 0.50 | 0.65 | 0.51 | 0.26 |
| 720.00 | 10.74 | 0.60 | 0.18 | 0.50 | 0.63 | 0.50 | 0.26 |
| 1260.00 | 16.84 | 0.56 | 0.16 | 0.42 | 0.54 | 0.43 | 0.24 |
| 1320.00 | 17.48 | 0.48 | 0.18 | 0.39 | 0.51 | 0.42 | 0.24 |
| 1380.00 | 18.13 | 0.50 | 0.18 | 0.40 | 0.51 | 0.41 | 0.26 |
| 1440.00 | 18.77 | 0.48 | 0.18 | 0.39 | 0.51 | 0.39 | 0.26 |

## ANALYTICAL DATA FOR SCREENING TEST NO.3

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 5.50 | 6.60 | 6.05 | 6.70 | | 6.65 | | 6.01 | | 6.68 | | 6.78 | | 6.65 | |
| COND | uHmos/cm | 875 | 950 | 913 | 1000 | | 680 | 25.5 | 630 | 31.0 | 610 | 33.2 | 335 | 63.3 | 580 | 36.4 |
| TURB | NTU | 1150 | 1225 | 1188 | 0.84 | 99.9 | 0.44 | 100.0 | 2.20 | 99.8 | 0.40 | 100.0 | 0.28 | 100.0 | 0.29 | 100.0 |
| TOC | mg/L | 650 | 1400 | 1025 | 42.0 | 95.9 | 32.0 | 96.9 | 32.0 | 96.9 | 24.0 | 97.7 | 8.0 | 99.2 | 22.0 | 97.9 |
| TDS | mg/L | 1070 | NA | 1070 | 660 | 38.3 | 320 | 70.1 | 430 | 59.8 | 420 | 60.7 | 165 | 84.6 | 325 | 69.6 |
| HARDNESS | mg/L | 36.13 | NA | 36.13 | 27.69 | 23.4 | 7.15 | 80.2 | 3.45 | 90.5 | 4.45 | 87.7 | 0.75 | 97.9 | 4.2 | 88.4 |
| DISS SIO2 | mg/L | 61.3 | NA | 61.3 | 40.0 | 34.7 | 40.9 | 33.3 | 35.7 | 41.8 | 42.3 | 31.0 | 42.3 | 31.0 | 41.2 | 32.8 |
| TSS | mg/L | 1706 | NA | 1706 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.3
% CUMULATIVE VOLUME REDUCTION
AUGUST 27 1984 VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 35.00 | 4.50 | 34.00 | 32.50 | 13.00 | 4.00 | 0.00 | | | 0.00 | 1.96 |
| 30.00 | 18.50 | 4.00 | 20.00 | 24.00 | 12.50 | 4.50 | 0.00 | | | 0.00 | 1.96 |
| 45.00 | 25.00 | 4.50 | 25.00 | 22.50 | 12.50 | 4.50 | 0.00 | | | 0.00 | 1.96 |
| 60.00 | 23.00 | 4.00 | 22.00 | 26.00 | 14.00 | 4.50 | 0.00 | 6.21 | 26.00 | 0.00 | 1.96 |
| 90.00 | 30.50 | 5.50 | 31.00 | 38.50 | 24.00 | 8.00 | 137.50 | | 26.00 | 0.80 | 1.96 |
| 120.00 | 24.50 | 5.00 | 25.00 | 32.50 | 22.00 | 7.50 | 116.50 | 5.50 | 26.00 | 1.49 | 1.92 |
| 150.00 | 22.00 | 5.00 | 22.50 | 29.50 | 21.00 | 7.50 | 107.50 | | 25.00 | 2.11 | 1.96 |
| 240.00 | 65.00 | 12.50 | 56.50 | 75.50 | 58.00 | 21.50 | 289.00 | 6.10 | 26.00 | 3.80 | 1.92 |
| 300.00 | 34.50 | 8.00 | 33.50 | 44.00 | 36.00 | 14.50 | 170.50 | 6.17 | 25.00 | 4.80 | 1.98 |
| 360.00 | 33.50 | 8.50 | 31.50 | 41.00 | 35.00 | 14.50 | 164.00 | 6.21 | 25.50 | 5.76 | 1.94 |
| 420.00 | 29.50 | 7.50 | 29.00 | 38.00 | 33.00 | 14.50 | 151.50 | 5.87 | 25.50 | 6.65 | 2.04 |
| 480.00 | 29.00 | 8.00 | 28.00 | 37.00 | 32.00 | 14.50 | 148.50 | 6.20 | 25.50 | 7.51 | 2.00 |
| 540.00 | 28.00 | 8.00 | 27.00 | 36.00 | 31.00 | 14.50 | 144.50 | 6.27 | 25.00 | 8.36 | 2.04 |
| 600.00 | 27.00 | 8.00 | 26.50 | 35.00 | 30.00 | 14.50 | 141.00 | | 25.00 | 9.18 | 2.00 |
| 660.00 | 26.00 | 7.50 | 24.50 | 33.50 | 28.50 | 14.50 | 134.50 | | 25.50 | 9.97 | 2.00 |
| 720.00 | 25.00 | 7.50 | 24.50 | 32.50 | 27.50 | 14.50 | 131.50 | | 25.50 | 10.74 | 2.00 |
| 1260.00 | 209.00 | 60.00 | 184.00 | 252.00 | 216.00 | 122.00 | 1043.00 | 6.43 | 25.00 | 16.84 | 2.04 |
| 1320.00 | 20.00 | 7.50 | 19.00 | 26.50 | 23.50 | 13.50 | 110.00 | 6.49 | 25.00 | 17.48 | 2.04 |
| 1380.00 | 21.00 | 7.50 | 19.50 | 26.50 | 22.50 | 14.50 | 111.50 | 6.59 | 25.00 | 18.13 | 2.04 |
| 1440.00 | 20.00 | 7.50 | 19.00 | 26.50 | 21.50 | 14.50 | 109.00 | 6.64 | 25.00 | 18.77 | 2.04 |

RUN NO. III
MEMBRANE: CHP
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 30.50 | 1.02 | 27.62 | 1.10 | 1.46 | 66.58 |
| 120.00 | 24.50 | 0.82 | 22.19 | 0.88 | 1.17 | |
| 150.00 | 22.00 | 0.73 | 19.92 | 0.79 | 1.05 | 70.79 |
| 240.00 | 65.00 | 0.72 | 19.62 | 0.78 | 1.04 | |
| 300.00 | 34.50 | 0.58 | 15.62 | 0.62 | 0.83 | 70.79 |
| 360.00 | 33.50 | 0.56 | 15.17 | 0.60 | 0.80 | |
| 420.00 | 29.50 | 0.49 | 13.36 | 0.53 | 0.71 | |
| 480.00 | 29.00 | 0.48 | 13.13 | 0.52 | 0.69 | 73.60 |
| 540.00 | 28.00 | 0.47 | 12.68 | 0.50 | 0.67 | |
| 600.00 | 27.00 | 0.45 | 12.23 | 0.49 | 0.65 | 69.39 |
| 660.00 | 26.00 | 0.43 | 11.77 | 0.47 | 0.62 | |
| 720.00 | 25.00 | 0.42 | 11.32 | 0.45 | 0.60 | |
| 1260.00 | 209.00 | 0.39 | 10.52 | 0.42 | 0.56 | |
| 1320.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.48 | 67.98 |
| 1380.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 | |
| 1440.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.48 | 69.39 |

RUN NO. III
MEMBRANE: PVDF
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 31.00 | 1.03 | 28.08 | 1.12 | 1.26 | 69.39 |
| 120.00 | 25.00 | 0.83 | 22.64 | 0.90 | 1.02 | |
| 150.00 | 22.50 | 0.75 | 20.38 | 0.81 | 0.92 | 67.98 |
| 240.00 | 56.50 | 0.63 | 17.06 | 0.68 | 0.77 | |
| 300.00 | 33.50 | 0.56 | 29.89 | 0.60 | 0.68 | 72.20 |
| 360.00 | 31.50 | 0.53 | 24.91 | 0.57 | 0.64 | |
| 420.00 | 29.00 | 0.48 | 24.45 | 0.52 | 0.59 | |
| 480.00 | 28.00 | 0.47 | 22.64 | 0.50 | 0.57 | 70.79 |
| 540.00 | 27.00 | 0.45 | 21.74 | 0.49 | 0.55 | |
| 600.00 | 26.50 | 0.44 | 20.83 | 0.48 | 0.54 | 70.79 |
| 660.00 | 24.50 | 0.41 | 19.47 | 0.44 | 0.50 | |
| 720.00 | 24.50 | 0.41 | 18.57 | 0.44 | 0.50 | |
| 1260.00 | 184.00 | 0.34 | 9.26 | 0.37 | 0.42 | |
| 1320.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.39 | 70.79 |
| 1380.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.40 | |
| 1440.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.39 | 70.79 |

RUN NO. III
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 5.50 | 0.18 | 4.98 | 0.20 | 0.26 | 70.79 |
| 120.00 | 5.00 | 0.17 | 4.53 | 0.18 | 0.24 | |
| 150.00 | 5.00 | 0.17 | 4.53 | 0.18 | 0.24 | 69.39 |
| 240.00 | 12.50 | 0.14 | 3.77 | 0.15 | 0.20 | |
| 300.00 | 8.00 | 0.13 | 3.62 | 0.14 | 0.19 | 70.79 |
| 360.00 | 8.50 | 0.14 | 3.85 | 0.15 | 0.20 | |
| 420.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | |
| 480.00 | 8.00 | 0.13 | 3.62 | 0.14 | 0.19 | 70.79 |
| 540.00 | 8.00 | 0.13 | 3.62 | 0.14 | 0.19 | |
| 600.00 | 8.00 | 0.13 | 3.62 | 0.14 | 0.19 | 70.79 |
| 660.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | |
| 720.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | |
| 1260.00 | 60.00 | 0.11 | 3.02 | 0.12 | 0.16 | |
| 1320.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | 70.79 |
| 1380.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | |
| 1440.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.18 | 67.98 |

RUN NO. III
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

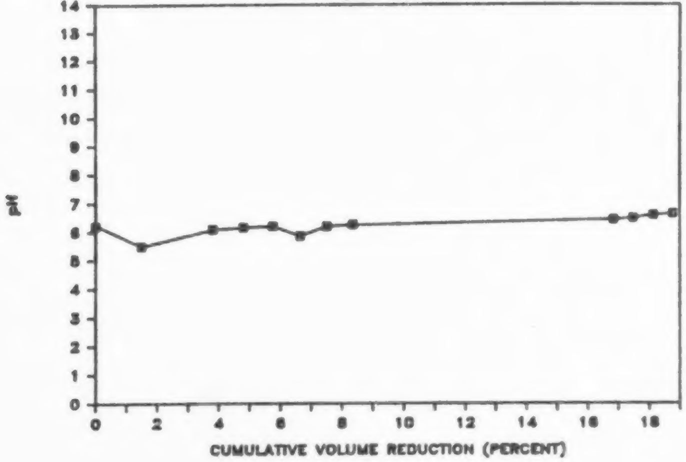
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 38.50 | 1.28 | 34.87 | 1.39 | 1.48 | 72.20 |
| 120.00 | 32.50 | 1.08 | 29.43 | 1.17 | 1.25 | |
| 150.00 | 29.50 | 0.98 | 26.72 | 1.06 | 1.14 | 63.77 |
| 240.00 | 75.50 | 0.84 | 22.79 | 0.91 | 0.97 | |
| 300.00 | 44.00 | 0.73 | 19.92 | 0.79 | 0.85 | 72.20 |
| 360.00 | 41.00 | 0.68 | 18.57 | 0.74 | 0.79 | |
| 420.00 | 38.00 | 0.63 | 17.21 | 0.68 | 0.73 | |
| 480.00 | 37.00 | 0.62 | 16.75 | 0.67 | 0.71 | 72.20 |
| 540.00 | 36.00 | 0.60 | 16.30 | 0.65 | 0.69 | |
| 600.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.67 | 72.20 |
| 660.00 | 33.50 | 0.56 | 15.17 | 0.60 | 0.65 | |
| 720.00 | 32.50 | 0.54 | 14.72 | 0.59 | 0.63 | |
| 1260.00 | 252.00 | 0.47 | 12.68 | 0.50 | 0.54 | |
| 1320.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.51 | 67.98 |
| 1380.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.51 | |
| 1440.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.51 | 67.98 |

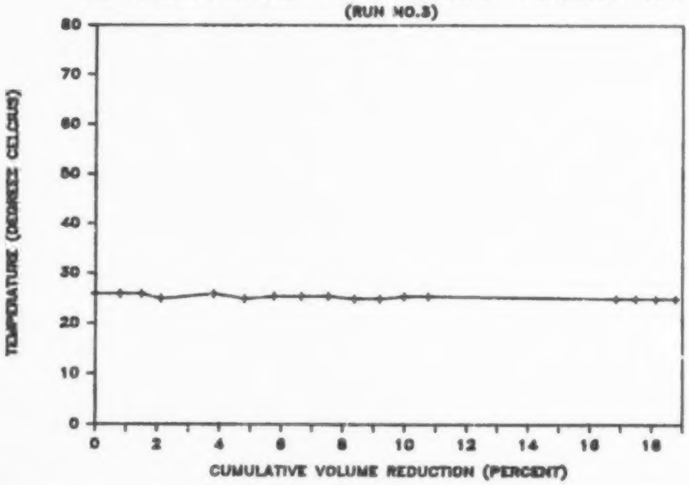
RUN NO. III
MEMBRANE: TFC
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

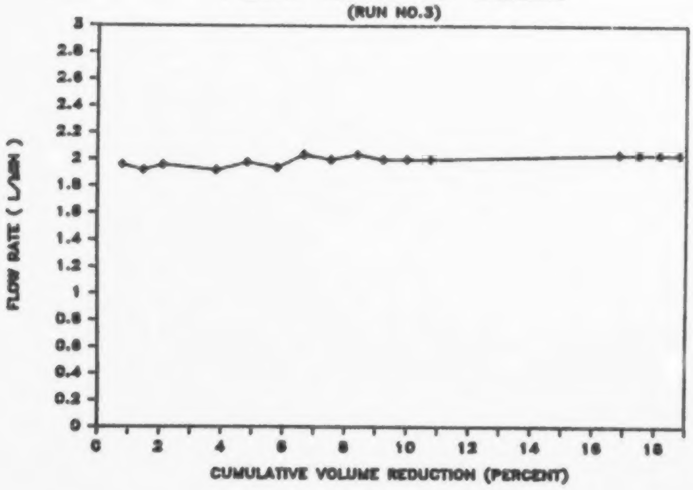
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 59.00 | | | | | |
| 90.00 | 24.00 | 0.80 | 21.74 | 0.86 | 0.86 | 67.98 |
| 120.00 | 22.00 | 0.73 | 19.92 | 0.79 | 0.79 | |
| 150.00 | 21.00 | 0.70 | 19.02 | 0.76 | 0.76 | 63.77 |
| 240.00 | 58.00 | 0.64 | 17.51 | 0.70 | 0.70 | |
| 300.00 | 36.00 | 0.60 | 16.30 | 0.65 | 0.65 | 73.60 |
| 360.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.63 | |
| 420.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.59 | |
| 480.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.58 | 70.79 |
| 540.00 | 31.00 | 0.52 | 14.04 | 0.56 | 0.56 | |
| 600.00 | 30.00 | 0.50 | 13.59 | 0.54 | 0.54 | 73.60 |
| 660.00 | 28.50 | 0.48 | 12.91 | 0.51 | 0.51 | |
| 720.00 | 27.50 | 0.46 | 12.45 | 0.50 | 0.50 | |
| 1260.00 | 216.00 | 0.40 | 10.87 | 0.43 | 0.43 | |
| 1320.00 | 23.50 | 0.39 | 10.64 | 0.42 | 0.42 | 70.79 |
| 1380.00 | 22.50 | 0.38 | 10.19 | 0.41 | 0.41 | |
| 1440.00 | 21.50 | 0.36 | 9.74 | 0.39 | 0.39 | 70.79 |

RUN NO. III
MEMBRANE: CELLULOSE
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 8.00 | 0.27 | 7.25 | 0.29 | 0.29 | 67.98 |
| 120.00 | 7.50 | 0.25 | 6.79 | 0.27 | 0.27 | |
| 150.00 | 7.50 | 0.25 | 6.79 | 0.27 | 0.27 | 62.36 |
| 240.00 | 21.50 | 0.24 | 6.49 | 0.26 | 0.26 | |
| 300.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | 72.20 |
| 360.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 420.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 480.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | 67.98 |
| 540.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 600.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | 67.98 |
| 660.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 720.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 1260.00 | 122.00 | 0.23 | 6.14 | 0.24 | 0.24 | |
| 1320.00 | 13.50 | 0.23 | 6.11 | 0.24 | 0.24 | 65.17 |
| 1380.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | |
| 1440.00 | 14.50 | 0.24 | 6.57 | 0.26 | 0.26 | 66.58 |


pH VS VOLUME REDUCTION
(RUN NO.3)


TEMPERATURE VS VOLUME REDUCTION
(RUN NO.3)


FLOW RATE TO CELLS
(RUN NO.3)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 4

Temp. =45 °C pH = 5.5 Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 0.98 | 0.86 | 1.03 | 1.71 | 1.89 | 0.92 | 0.40 |
| 120.00 | 2.02 | 0.89 | 1.08 | 1.81 | 2.04 | 1.01 | 0.45 |
| 150.00 | 2.88 | 0.81 | 0.93 | 1.44 | 1.66 | 0.76 | 0.38 |
| 180.00 | 3.67 | 0.77 | 0.93 | 1.26 | 1.54 | 0.70 | 0.34 |
| 240.00 | 5.18 | 0.78 | 0.95 | 1.12 | 1.46 | 0.67 | 0.33 |
| 300.00 | 6.67 | 0.72 | 1.17 | 1.03 | 1.41 | 0.62 | 0.32 |
| 360.00 | 8.11 | 0.69 | 1.14 | 0.98 | 1.35 | 0.59 | 0.33 |
| 420.00 | 9.36 | 0.65 | 1.04 | 0.83 | 1.14 | 0.49 | 0.30 |
| 480.00 | 10.60 | 0.54 | 1.01 | 0.83 | 1.16 | 0.51 | 0.32 |
| 540.00 | 11.77 | 0.50 | 0.98 | 0.78 | 1.08 | 0.48 | 0.32 |
| 600.00 | 12.95 | 0.55 | 1.03 | 0.77 | 1.05 | 0.45 | 0.32 |
| 660.00 | 14.05 | 0.50 | 0.97 | 0.72 | 0.97 | 0.42 | 0.30 |
| 720.00 | 15.11 | 0.48 | 0.96 | 0.69 | 0.94 | 0.41 | 0.29 |
| 1380.00 | 24.91 | 0.42 | 0.79 | 0.58 | 0.81 | 0.29 | 0.27 |
| 1440.00 | 25.69 | 0.29 | 0.68 | 0.53 | 0.74 | 0.24 | 0.27 |
| 1500.00 | 26.37 | 0.28 | 0.60 | 0.47 | 0.64 | 0.20 | 0.23 |

ANALYTICAL DATA FOR SCREENING TEST NO.4

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 6.05 | 6.63 | 6.34 | 6.94 | | 7.01 | | 6.99 | | 6.92 | | 6.98 | | 6.91 | |
| COND | uHmos/cm | 850 | 1150 | 1000 | 940 | 6.0 | 540 | 46.0 | 550 | 45.0 | 465 | 53.5 | 220 | 78.0 | 470 | 53.0 |
| TURB | NTU | 850 | 1800 | 1325 | 1.00 | 99.9 | 0.68 | 99.9 | 0.52 | 100.0 | 0.60 | 100.0 | 0.40 | 100.0 | 0.72 | 99.9 |
| TOC | mg/L | 1202 | 1320 | 1261 | 62.0 | 95.1 | 32.0 | 97.5 | 32.0 | 97.5 | 21.0 | 98.3 | 8.0 | 99.4 | 26.0 | 97.9 |
| TDS | mg/L | 1050 | NA | 1050 | 740 | 29.5 | 455 | 56.7 | 475 | 54.8 | 460 | 56.2 | 230 | 78.1 | 395 | 62.4 |
| HARDNESS | mg/L | 13.74 | NA | 13.74 | 22.85 | -66.3 | 4.49 | 67.3 | 2.53 | 81.6 | 2.57 | 81.3 | 0.25 | 98.2 | 2.82 | 79.5 |
| DIS SIO2 | mg/L | 84.8 | NA | 84.8 | 68.7 | 19.0 | 69.8 | 17.7 | 69.8 | 17.7 | 68.2 | 19.6 | 58.8 | 30.7 | 71.6 | 15.6 |
| TSS | mg/L | 1015 | NA | 1015 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.4
% CUMULATIVE VOLUME REDUCTION
AUGUST 29 1984
VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 16.00 | 18.00 | 48.50 | 53.00 | 14.00 | 6.00 | 0.00 | | | 0.00 | 1.84 |
| 30.00 | 11.00 | 18.00 | 33.00 | 38.00 | 16.00 | 7.50 | 0.00 | | | 0.00 | 2.12 |
| 45.00 | 13.00 | 18.00 | 32.50 | 38.00 | 18.00 | 7.50 | 0.00 | | | 0.00 | 2.28 |
| 60.00 | 11.00 | 14.50 | 27.50 | 32.00 | 16.00 | 6.50 | 0.00 | 5.70 | 43.00 | 0.00 | 1.80 |
| 90.00 | 18.00 | 21.50 | 42.00 | 49.00 | 25.50 | 11.00 | 167.00 | 5.70 | 42.00 | 0.98 | 1.80 |
| 120.00 | 18.50 | 22.50 | 44.50 | 53.00 | 28.00 | 12.50 | 179.00 | 7.50 | 46.00 | 2.02 | 2.32 |
| 150.00 | 17.00 | 19.50 | 35.50 | 43.00 | 21.00 | 10.50 | 146.50 | 7.50 | 44.00 | 2.88 | 1.92 |
| 180.00 | 16.00 | 19.50 | 31.00 | 40.00 | 19.50 | 9.50 | 135.50 | 7.66 | 42.00 | 3.67 | 1.88 |
| 240.00 | 32.50 | 39.50 | 55.00 | 76.00 | 37.00 | 18.50 | 258.50 | 7.66 | 47.00 | 5.18 | 2.06 |
| 300.00 | 30.00 | 49.00 | 50.50 | 73.00 | 34.50 | 17.50 | 254.50 | 6.11 | 42.00 | 6.67 | 1.88 |
| 360.00 | 29.00 | 47.50 | 48.00 | 70.00 | 33.00 | 18.50 | 246.00 | 6.63 | 48.00 | 8.11 | 2.00 |
| 420.00 | 27.00 | 43.50 | 41.00 | 59.00 | 27.00 | 16.50 | 214.00 | 6.78 | 44.00 | 9.36 | 1.80 |
| 480.00 | 22.50 | 42.00 | 41.00 | 60.00 | 28.50 | 18.00 | 212.00 | 6.03 | 45.00 | 10.60 | 2.04 |
| 540.00 | 21.00 | 41.00 | 38.50 | 56.00 | 26.50 | 17.50 | 200.50 | 5.93 | 44.00 | 11.77 | 2.00 |
| 600.00 | 23.00 | 43.00 | 38.00 | 54.50 | 25.00 | 17.50 | 201.00 | 6.27 | 44.00 | 12.95 | 1.92 |
| 660.00 | 21.00 | 40.50 | 35.50 | 50.50 | 23.50 | 16.50 | 187.50 | 6.36 | 45.00 | 14.05 | 1.88 |
| 720.00 | 20.00 | 40.00 | 34.00 | 49.00 | 22.50 | 16.00 | 181.50 | 6.55 | 44.00 | 15.11 | 1.88 |
| 1380.00 | 193.00 | 365.00 | 315.00 | 462.00 | 175.00 | 166.00 | 1676.00 | 6.05 | 48.00 | 24.91 | 2.00 |
| 1440.00 | 12.00 | 28.50 | 26.00 | 38.50 | 13.50 | 15.00 | 133.50 | 6.54 | 46.00 | 25.69 | 2.16 |
| 1500.00 | 11.50 | 25.00 | 23.00 | 33.00 | 11.00 | 12.50 | 116.00 | 6.73 | 44.00 | 26.37 | 2.00 |

RUN NO. IV
MEMBRANE: CHP
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE MLS/MIN | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | 73.60 |
| 90.00 | 18.00 | 0.60 | 16.30 | 0.65 | 0.86 | |
| 120.00 | 18.50 | 0.62 | 16.75 | 0.67 | 0.89 | 70.79 |
| 150.00 | 17.00 | 0.57 | 15.40 | 0.61 | 0.81 | |
| 180.00 | 16.00 | 0.53 | 14.49 | 0.58 | 0.77 | |
| 240.00 | 32.50 | 0.54 | 14.72 | 0.59 | 0.78 | 70.79 |
| 300.00 | 30.00 | 0.50 | 13.59 | 0.54 | 0.72 | |
| 360.00 | 29.00 | 0.48 | 13.13 | 0.52 | 0.69 | 70.79 |
| 420.00 | 27.00 | 0.45 | 12.23 | 0.49 | 0.65 | |
| 480.00 | 22.50 | 0.38 | 10.19 | 0.41 | 0.54 | 75.01 |
| 540.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 | |
| 600.00 | 23.00 | 0.38 | 10.42 | 0.41 | 0.55 | 67.98 |
| 660.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 | |
| 720.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.48 | 70.79 |
| 1380.00 | 193.00 | 0.29 | 7.95 | 0.32 | 0.42 | |
| 1440.00 | 12.00 | 0.20 | 5.43 | 0.22 | 0.29 | |
| 1500.00 | 11.50 | 0.19 | 5.21 | 0.21 | 0.28 | 69.39 |

RUN NO. IV
MEMBRANE: PVDF
PRESSURE: 120.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE MLS/MIN | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 133.50 | | | | | 72.20 |
| 90.00 | 42.00 | 1.40 | 38.04 | 1.51 | 1.71 | |
| 120.00 | 44.50 | 1.48 | 40.30 | 1.60 | 1.81 | 66.58 |
| 150.00 | 35.50 | 1.18 | 32.15 | 1.28 | 1.44 | |
| 180.00 | 31.00 | 1.03 | 28.08 | 1.12 | 1.26 | |
| 240.00 | 55.00 | 0.92 | 29.89 | 0.99 | 1.12 | 70.79 |
| 300.00 | 50.50 | 0.84 | 24.91 | 0.91 | 1.03 | |
| 360.00 | 48.00 | 0.80 | 24.45 | 0.86 | 0.98 | 69.39 |
| 420.00 | 41.00 | 0.68 | 22.64 | 0.74 | 0.83 | |
| 480.00 | 41.00 | 0.68 | 21.74 | 0.74 | 0.83 | 73.60 |
| 540.00 | 38.50 | 0.64 | 20.83 | 0.69 | 0.78 | |
| 600.00 | 38.00 | 0.63 | 19.47 | 0.68 | 0.77 | 70.79 |
| 660.00 | 35.50 | 0.59 | 18.57 | 0.64 | 0.72 | |
| 720.00 | 34.00 | 0.57 | 15.40 | 0.61 | 0.69 | 72.20 |
| 1380.00 | 315.00 | 0.48 | 12.97 | 0.52 | 0.58 | |
| 1440.00 | 26.00 | 0.43 | 11.77 | 0.47 | 0.53 | |
| 1500.00 | 23.00 | 0.38 | 10.42 | 0.41 | 0.47 | 67.98 |

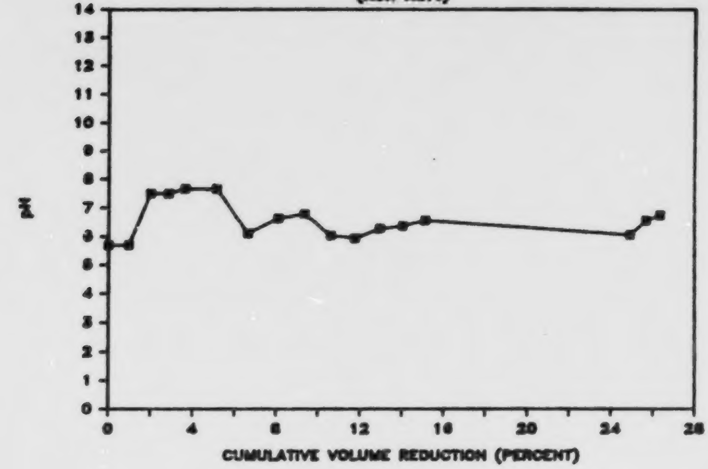
RUN NO. IV
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE MLS/MIN | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 118.50 | | | | | 70.79 |
| 90.00 | 21.50 | 0.72 | 19.47 | 0.77 | 1.03 | |
| 120.00 | 22.50 | 0.75 | 20.38 | 0.81 | 1.08 | 69.39 |
| 150.00 | 19.50 | 0.65 | 17.66 | 0.70 | 0.93 | |
| 180.00 | 19.50 | 0.65 | 17.66 | 0.70 | 0.93 | |
| 240.00 | 39.50 | 0.66 | 17.89 | 0.71 | 0.95 | 73.60 |
| 300.00 | 49.00 | 0.82 | 22.19 | 0.88 | 1.17 | |
| 360.00 | 47.50 | 0.79 | 21.51 | 0.86 | 1.14 | 70.79 |
| 420.00 | 43.50 | 0.73 | 19.70 | 0.78 | 1.04 | |
| 480.00 | 42.00 | 0.70 | 19.02 | 0.76 | 1.01 | 70.79 |
| 540.00 | 41.00 | 0.68 | 18.57 | 0.74 | 0.98 | |
| 600.00 | 43.00 | 0.72 | 19.47 | 0.77 | 1.03 | 67.98 |
| 660.00 | 40.50 | 0.68 | 18.34 | 0.73 | 0.97 | |
| 720.00 | 40.00 | 0.67 | 18.11 | 0.72 | 0.96 | 70.79 |
| 1380.00 | 365.00 | 0.55 | 15.03 | 0.60 | 0.79 | |
| 1440.00 | 28.50 | 0.48 | 12.91 | 0.51 | 0.68 | |
| 1500.00 | 25.00 | 0.42 | 11.32 | 0.45 | 0.60 | 70.79 |

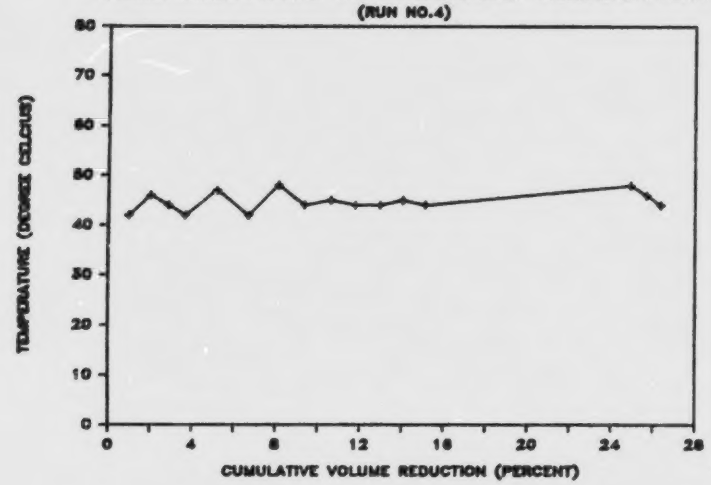
RUN NO. IV
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE MLS/MIN | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 149.00 | | | | | 72.20 |
| 90.00 | 49.00 | 1.63 | 44.38 | 1.76 | 1.89 | |
| 120.00 | 53.00 | 1.77 | 48.00 | 1.91 | 2.04 | 70.79 |
| 150.00 | 43.00 | 1.43 | 38.94 | 1.55 | 1.66 | |
| 180.00 | 40.00 | 1.33 | 36.23 | 1.44 | 1.54 | |
| 240.00 | 76.00 | 1.27 | 34.42 | 1.37 | 1.46 | 70.79 |
| 300.00 | 73.00 | 1.22 | 33.06 | 1.31 | 1.41 | |
| 360.00 | 70.00 | 1.17 | 31.70 | 1.26 | 1.35 | 73.60 |
| 420.00 | 59.00 | 0.98 | 26.72 | 1.06 | 1.14 | |
| 480.00 | 60.00 | 1.00 | 27.17 | 1.08 | 1.16 | 70.79 |
| 540.00 | 56.00 | 0.93 | 25.36 | 1.01 | 1.08 | |
| 600.00 | 54.50 | 0.91 | 24.68 | 0.98 | 1.05 | 67.98 |
| 660.00 | 50.50 | 0.84 | 22.87 | 0.91 | 0.97 | |
| 720.00 | 49.00 | 0.82 | 22.19 | 0.88 | 0.94 | 72.20 |
| 1380.00 | 462.00 | 0.70 | 19.02 | 0.76 | 0.81 | |
| 1440.00 | 38.50 | 0.64 | 17.43 | 0.69 | 0.74 | |
| 1500.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.64 | 72.20 |

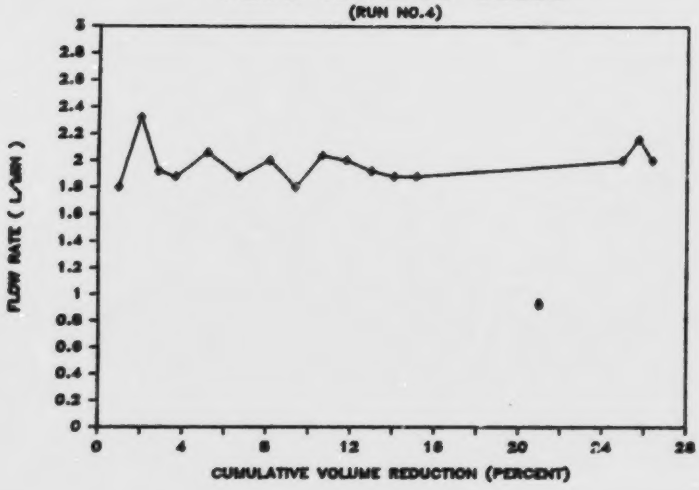
```
                         RUN NO.  IV
                         MEMBRANE: TFC
                         PRESSURE:  150.00 psi
                         PRESSURE CORRECTION FACTOR 1.00
   TIME    PERMEATE PERMEATE   FLUX      FLUX      FLUX     SURFACE
            VOLUME    RATE     RATE      RATE      RATE     TENSION
   (MIN)    (MLS)   MLS/MIN (US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
    60.00    59.00                                           70.79
    90.00    25.50     0.85    23.09     0.92      0.92
   120.00    28.00     0.93    25.36     1.01      1.01      70.79
   150.00    21.00     0.70    19.02     0.76      0.76
   180.00    19.50     0.65    17.66     0.70      0.70
   240.00    37.00     0.62    16.75     0.67      0.67      73.60
   300.00    34.50     0.58    15.62     0.62      0.62
   360.00    33.00     0.55    14.94     0.59      0.59      70.79
   420.00    27.00     0.45    12.23     0.49      0.49
   480.00    28.50     0.48    12.91     0.51      0.51      70.79
   540.00    26.50     0.44    12.00     0.48      0.48
   600.00    25.00     0.42    11.32     0.45      0.45      66.58
   660.00    23.50     0.39    10.64     0.42      0.42
   720.00    22.50     0.38    10.19     0.41      0.41      66.58
  1380.00   175.00     0.27     7.20     0.29      0.29
  1440.00    13.50     0.23     6.11     0.24      0.24
  1500.00    11.00     0.18     4.98     0.20      0.20      67.98
                         RUN NO.  IV
                         MEMBRANE: CELLULOSE
                         PRESSURE:  150.00 psi
                         PRESSURE CORRECTION FACTOR 1.00
   TIME    PERMEATE PERMEATE   FLUX      FLUX      FLUX     SURFACE
            VOLUME    RATE     RATE      RATE      RATE     TENSION
   (MIN)    (MLS)   MLS/MIN (US GFD) (M3/M2·D)(M3/M2·D)(DYNES/CM)
    60.00    17.00                                           67.98
    90.00    11.00     0.37     9.96     0.40      0.40
   120.00    12.50     0.42    11.32     0.45      0.45      67.98
   150.00    10.50     0.35     9.51     0.38      0.38
   180.00     9.50     0.32     8.60     0.34      0.34
   240.00    18.50     0.31     8.38     0.33      0.33      70.79
   300.00    17.50     0.29     7.92     0.32      0.32
   360.00    18.50     0.31     8.38     0.33      0.33      69.39
   420.00    16.50     0.28     7.47     0.30      0.30
   480.00    18.00     0.30     8.15     0.32      0.32      63.77
   540.00    17.50     0.29     7.92     0.32      0.32
   600.00    17.50     0.29     7.92     0.32      0.32      70.79
   660.00    16.50     0.28     7.47     0.30      0.30
   720.00    16.00     0.27     7.25     0.29      0.29      70.79
  1380.00   166.00     0.25     6.83     0.27      0.27
  1440.00    15.00     0.25     6.79     0.27      0.27
  1500.00    12.50     0.21     5.66     0.23      0.23      70.79
```



pH VS VOLUME REDUCTION
(RUN NO.4)



TEMPERATURE VS VOLUME REDUCTION
(RUN NO.4)



FLOW RATE TO CELLS
(RUN NO.4)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 5

Temp. = 25°C pH = 9.5 Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 1.28 | 1.68 | 1.92 | 1.65 | 2.29 | 1.30 | 0.29 |
| 120.00 | 2.25 | 1.22 | 1.44 | 1.22 | 1.75 | 1.01 | 0.23 |
| 150.00 | 3.05 | 1.01 | 1.17 | 1.00 | 1.44 | 0.85 | 0.22 |
| 180.00 | 3.81 | 0.96 | 1.10 | 0.94 | 1.35 | 0.85 | 0.22 |
| 210.00 | 4.56 | 0.93 | 1.05 | 0.89 | 1.31 | 0.85 | 0.22 |
| 240.00 | 5.27 | 0.89 | 1.01 | 0.85 | 1.23 | 0.83 | 0.22 |
| 300.00 | 6.62 | 0.87 | 0.93 | 0.78 | 1.18 | 0.81 | 0.21 |
| 360.00 | 7.99 | 0.84 | 0.95 | 0.75 | 1.19 | 0.85 | 0.23 |
| 420.00 | 9.31 | 0.84 | 0.87 | 0.71 | 1.18 | 0.81 | 0.24 |
| 480.00 | 10.55 | 0.77 | 0.81 | 0.66 | 1.12 | 0.76 | 0.24 |
| 540.00 | 11.72 | 0.71 | 0.75 | 0.61 | 1.08 | 0.71 | 0.24 |
| 600.00 | 12.75 | 0.63 | 0.67 | 0.55 | 0.91 | 0.61 | 0.22 |
| 660.00 | 13.73 | 0.61 | 0.65 | 0.53 | 0.88 | 0.59 | 0.22 |
| 720.00 | 14.65 | 0.56 | 0.62 | 0.49 | 0.82 | 0.54 | 0.21 |
| 1380.00 | 23.79 | 0.53 | 0.54 | 0.43 | 0.72 | 0.48 | 0.21 |
| 1440.00 | 24.56 | 0.47 | 0.51 | 0.40 | 0.66 | 0.45 | 0.21 |
| 1500.00 | 25.31 | 0.45 | 0.50 | 0.39 | 0.65 | 0.44 | 0.21 |

## ANALYTICAL DATA FOR SCREENING TEST NO.5

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 9.62 | 9.35 | 9.49 | 9.27 | | 9.14 | | 8.95 | | 9.01 | | 8.62 | | 8.93 | |
| COND | uHmos/cm | 1140 | 1280 | 1210 | 1040 | 14.0 | 800 | 33.9 | 610 | 49.6 | 640 | 47.1 | 274 | 77.4 | 585 | 51.7 |
| TURB | NTU | 950 | 1750 | 1350 | 0.87 | 99.9 | 0.76 | 99.9 | 0.44 | 100.0 | 0.47 | 100.0 | 0.12 | 100.0 | 0.38 | 100.0 |
| TOC | mg/L | 1650 | 1050 | 1350 | 92 | 93.2 | 88 | 93.5 | 66 | 95.1 | 76.5 | 94.3 | 44.5 | 96.7 | 53.5 | 96.0 |
| TDS | mg/L | 1155 | NA | 1155 | 705 | 39.0 | 550 | 52.4 | 420 | 63.6 | 445 | 61.5 | 160 | 86.1 | 430 | 62.8 |
| HARDNESS | mg/L | 6.06 | NA | 6.06 | 1.66 | 72.6 | 0.29 | 95.2 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 |
| DIS SIO2 | mg/L | 82.5 | NA | 82.5 | 47 | 43.0 | 55.7 | 32.5 | 54.1 | 34.4 | 55.9 | 32.2 | 49.7 | 39.8 | 55.2 | 33.1 |
| TSS | mg/L | 1580 | NA | 1580 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.5
% CUMULATIVE VOLUME REDUCTION
SEPTEMBER 4 1984 VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 41.50 | 32.50 | 48.00 | 44.00 | 17.00 | 4.50 | 0.00 | | | 0.00 | 2.00 |
| 30.00 | 26.50 | 40.50 | 32.50 | 39.00 | 20.50 | 4.50 | 0.00 | | | 0.00 | 2.02 |
| 45.00 | 22.00 | 29.00 | 29.50 | 35.00 | 20.00 | 4.50 | 0.00 | | | 0.00 | 2.00 |
| 60.00 | 19.00 | 24.50 | 24.00 | 32.50 | 19.00 | 4.00 | 0.00 | 9.47 | 27.00 | 0.00 | 2.04 |
| 90.00 | 35.00 | 40.00 | 40.50 | 59.50 | 36.00 | 8.00 | 219.00 | 9.47 | 27.00 | 1.28 | 2.00 |
| 120.00 | 25.50 | 30.00 | 30.00 | 45.50 | 28.00 | 6.50 | 165.50 | 9.49 | 23.00 | 2.25 | 1.94 |
| 150.00 | 21.00 | 24.50 | 24.50 | 37.50 | 23.50 | 6.00 | 137.00 | 9.49 | 23.00 | 3.05 | 1.84 |
| 180.00 | 20.00 | 23.00 | 23.00 | 35.00 | 23.50 | 6.00 | 130.50 | 9.49 | 24.00 | 3.81 | 1.98 |
| 210.00 | 19.50 | 22.00 | 22.00 | 34.00 | 23.50 | 6.00 | 127.00 | 9.51 | 23.00 | 4.56 | 1.96 |
| 240.00 | 18.50 | 21.00 | 21.00 | 32.00 | 23.00 | 6.00 | 121.50 | 9.51 | 23.00 | 5.27 | 2.00 |
| 300.00 | 36.50 | 39.00 | 38.50 | 61.50 | 45.00 | 11.50 | 232.00 | 9.15 | 24.00 | 6.62 | 1.92 |
| 360.00 | 35.00 | 39.50 | 37.00 | 62.00 | 47.00 | 13.00 | 233.50 | 9.43 | 25.00 | 7.99 | 1.92 |
| 420.00 | 35.00 | 36.50 | 35.00 | 61.50 | 45.00 | 13.50 | 226.50 | 9.41 | 24.00 | 9.31 | 2.04 |
| 480.00 | 32.00 | 34.00 | 32.50 | 58.00 | 42.00 | 13.50 | 212.00 | 9.40 | 24.00 | 10.55 | 2.00 |
| 540.00 | 29.50 | 31.50 | 30.00 | 56.00 | 39.50 | 13.50 | 200.00 | 9.39 | 25.00 | 11.72 | 1.96 |
| 600.00 | 26.50 | 28.00 | 27.00 | 47.50 | 34.00 | 12.00 | 175.00 | 9.38 | 24.00 | 12.75 | 2.08 |
| 660.00 | 25.50 | 27.00 | 26.00 | 45.50 | 33.00 | 12.00 | 169.00 | 9.36 | 24.00 | 13.73 | 1.96 |
| 720.00 | 23.50 | 26.00 | 24.00 | 42.50 | 30.00 | 11.50 | 157.50 | 9.36 | 24.00 | 14.65 | 2.00 |
| 1380.00 | 245.00 | 250.00 | 235.00 | 410.00 | 295.00 | 127.00 | 1562.00 | 9.35 | 24.00 | 23.79 | 2.00 |
| 1440.00 | 19.50 | 21.50 | 19.50 | 34.50 | 25.00 | 11.50 | 131.50 | 9.35 | 23.00 | 24.56 | 1.96 |
| 1500.00 | 19.00 | 21.00 | 19.00 | 34.00 | 24.50 | 11.50 | 129.00 | 9.35 | 23.00 | 25.31 | 2.00 |

RUN NO. V
MEMBRANE: CHP
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 35.00 | 1.17 | 31.70 | 1.26 | 1.68 | 70.79 |
| 120.00 | 25.50 | 0.85 | 23.09 | 0.92 | 1.22 | |
| 150.00 | 21.00 | 0.70 | 19.02 | 0.76 | 1.01 | |
| 180.00 | 20.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 210.00 | 19.50 | 0.65 | 17.66 | 0.70 | 0.93 | 69.39 |
| 240.00 | 18.50 | 0.62 | 16.75 | 0.67 | 0.89 | |
| 300.00 | 36.50 | 0.61 | 16.53 | 0.66 | 0.87 | |
| 360.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.84 | 65.17 |
| 420.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.84 | |
| 480.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.77 | 67.98 |
| 540.00 | 29.50 | 0.49 | 13.36 | 0.53 | 0.71 | |
| 600.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.63 | 70.79 |
| 660.00 | 25.50 | 0.43 | 11.55 | 0.46 | 0.61 | |
| 720.00 | 23.50 | 0.39 | 10.64 | 0.42 | 0.56 | 70.79 |
| 1380.00 | 245.00 | 0.37 | 10.09 | 0.40 | 0.53 | |
| 1440.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.47 | 69.39 |
| 1500.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.45 | |

RUN NO. V
MEMBRANE: PVDF
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 133.50 | | | | | |
| 90.00 | 40.50 | 1.35 | 36.68 | 1.46 | 1.65 | 69.39 |
| 120.00 | 30.00 | 1.00 | 27.17 | 1.08 | 1.22 | |
| 150.00 | 24.50 | 0.82 | 22.19 | 0.88 | 1.00 | |
| 180.00 | 23.00 | 0.77 | 20.83 | 0.83 | 0.94 | |
| 210.00 | 22.00 | 0.73 | 29.89 | 0.79 | 0.89 | 66.58 |
| 240.00 | 21.00 | 0.70 | 24.91 | 0.76 | 0.85 | |
| 300.00 | 38.50 | 0.64 | 24.45 | 0.69 | 0.78 | |
| 360.00 | 37.00 | 0.62 | 22.64 | 0.67 | 0.75 | 72.20 |
| 420.00 | 35.00 | 0.58 | 21.74 | 0.63 | 0.71 | |
| 480.00 | 32.50 | 0.54 | 20.83 | 0.59 | 0.66 | 67.98 |
| 540.00 | 30.00 | 0.50 | 19.47 | 0.54 | 0.61 | |
| 600.00 | 27.00 | 0.45 | 18.57 | 0.49 | 0.55 | 69.39 |
| 660.00 | 26.00 | 0.43 | 11.77 | 0.47 | 0.53 | |
| 720.00 | 24.00 | 0.40 | 10.87 | 0.43 | 0.49 | 69.39 |
| 1380.00 | 235.00 | 0.36 | 9.67 | 0.38 | 0.43 | |
| 1440.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.40 | 70.79 |
| 1500.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.39 | |

RUN NO. V
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 40.00 | 1.33 | 36.23 | 1.44 | 1.92 | 70.79 |
| 120.00 | 30.00 | 1.00 | 27.17 | 1.08 | 1.44 | |
| 150.00 | 24.50 | 0.82 | 22.19 | 0.88 | 1.17 | |
| 180.00 | 23.00 | 0.77 | 20.83 | 0.83 | 1.10 | |
| 210.00 | 22.00 | 0.73 | 19.92 | 0.79 | 1.05 | 70.79 |
| 240.00 | 21.00 | 0.70 | 19.02 | 0.76 | 1.01 | |
| 300.00 | 39.00 | 0.65 | 17.66 | 0.70 | 0.93 | |
| 360.00 | 39.50 | 0.66 | 17.89 | 0.71 | 0.95 | 66.58 |
| 420.00 | 36.50 | 0.61 | 16.53 | 0.66 | 0.87 | |
| 480.00 | 34.00 | 0.57 | 15.40 | 0.61 | 0.81 | 67.98 |
| 540.00 | 31.50 | 0.53 | 14.26 | 0.57 | 0.75 | |
| 600.00 | 28.00 | 0.47 | 12.68 | 0.50 | 0.67 | 69.39 |
| 660.00 | 27.00 | 0.45 | 12.23 | 0.49 | 0.65 | |
| 720.00 | 26.00 | 0.43 | 11.77 | 0.47 | 0.62 | 67.98 |
| 1380.00 | 250.00 | 0.38 | 10.29 | 0.41 | 0.54 | |
| 1440.00 | 21.50 | 0.36 | 9.74 | 0.39 | 0.51 | 67.98 |
| 1500.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 | |

RUN NO. V
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

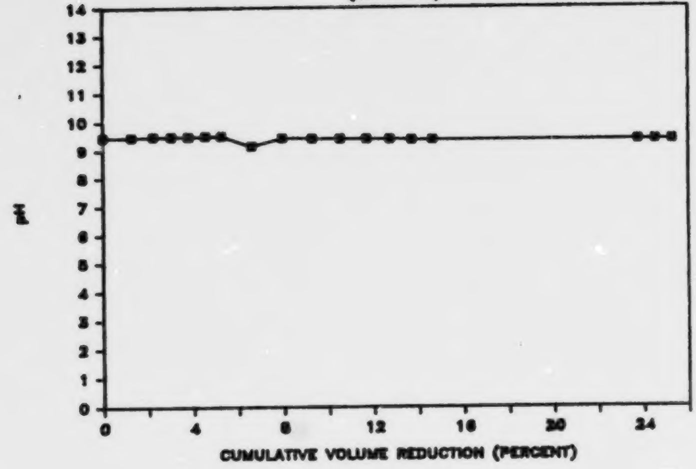
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 149.00 | | | | | |
| 90.00 | 59.50 | 1.98 | 53.89 | 2.14 | 2.29 | 69.39 |
| 120.00 | 45.50 | 1.52 | 41.21 | 1.64 | 1.75 | |
| 150.00 | 37.50 | 1.25 | 33.96 | 1.35 | 1.44 | |
| 180.00 | 35.00 | 1.17 | 31.70 | 1.26 | 1.35 | |
| 210.00 | 34.00 | 1.13 | 30.79 | 1.22 | 1.31 | 70.79 |
| 240.00 | 32.00 | 1.07 | 28.98 | 1.15 | 1.23 | |
| 300.00 | 61.50 | 1.03 | 27.85 | 1.11 | 1.18 | |
| 360.00 | 62.00 | 1.03 | 28.08 | 1.12 | 1.19 | 53.93 |
| 420.00 | 61.50 | 1.03 | 27.85 | 1.11 | 1.18 | |
| 480.00 | 58.00 | 0.97 | 26.26 | 1.04 | 1.12 | 67.98 |
| 540.00 | 56.00 | 0.93 | 25.36 | 1.01 | 1.08 | |
| 600.00 | 47.50 | 0.79 | 21.51 | 0.86 | 0.91 | 70.79 |
| 660.00 | 45.50 | 0.76 | 20.60 | 0.82 | 0.88 | |
| 720.00 | 42.50 | 0.71 | 19.25 | 0.77 | 0.82 | 69.39 |
| 1380.00 | 410.00 | 0.62 | 16.88 | 0.67 | 0.72 | |
| 1440.00 | 34.50 | 0.58 | 15.62 | 0.62 | 0.66 | 70.79 |
| 1500.00 | 34.00 | 0.57 | 15.40 | 0.61 | 0.65 | |

RUN NO. V
MEMBRANE: TFC
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

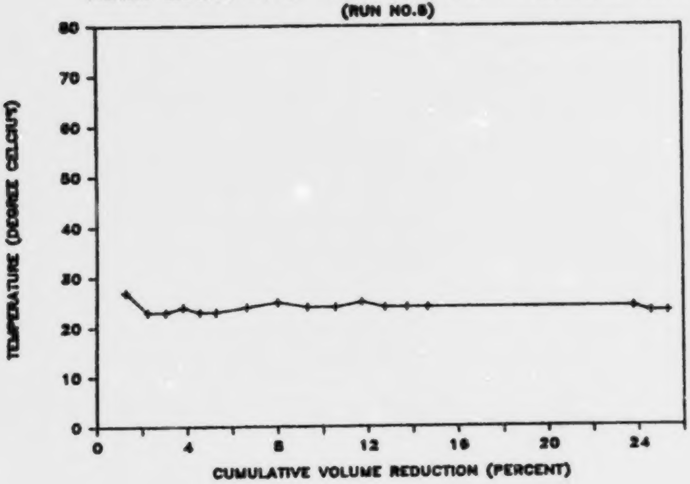
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 59.00 | | | | | |
| 90.00 | 36.00 | 1.20 | 32.60 | 1.30 | 1.30 | 72.20 |
| 120.00 | 28.00 | 0.93 | 25.36 | 1.01 | 1.01 | |
| 150.00 | 23.50 | 0.78 | 21.28 | 0.85 | 0.85 | |
| 180.00 | 23.50 | 0.78 | 21.28 | 0.85 | 0.85 | |
| 210.00 | 23.50 | 0.78 | 21.28 | 0.85 | 0.85 | 65.17 |
| 240.00 | 23.00 | 0.77 | 20.83 | 0.83 | 0.83 | |
| 300.00 | 45.00 | 0.75 | 20.38 | 0.81 | 0.81 | |
| 360.00 | 47.00 | 0.78 | 21.28 | 0.85 | 0.85 | 69.39 |
| 420.00 | 45.00 | 0.75 | 20.38 | 0.81 | 0.81 | |
| 480.00 | 42.00 | 0.70 | 19.02 | 0.76 | 0.76 | 67.98 |
| 540.00 | 39.50 | 0.66 | 17.89 | 0.71 | 0.71 | |
| 600.00 | 34.00 | 0.57 | 15.40 | 0.61 | 0.61 | 70.79 |
| 660.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.59 | |
| 720.00 | 30.00 | 0.50 | 13.59 | 0.54 | 0.54 | 67.98 |
| 1380.00 | 295.00 | 0.45 | 12.14 | 0.48 | 0.48 | |
| 1440.00 | 25.00 | 0.42 | 11.32 | 0.45 | 0.45 | 72.20 |
| 1500.00 | 24.50 | 0.41 | 11.09 | 0.44 | 0.44 | |

RUN NO. V
MEMBRANE: CELLULOSE
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

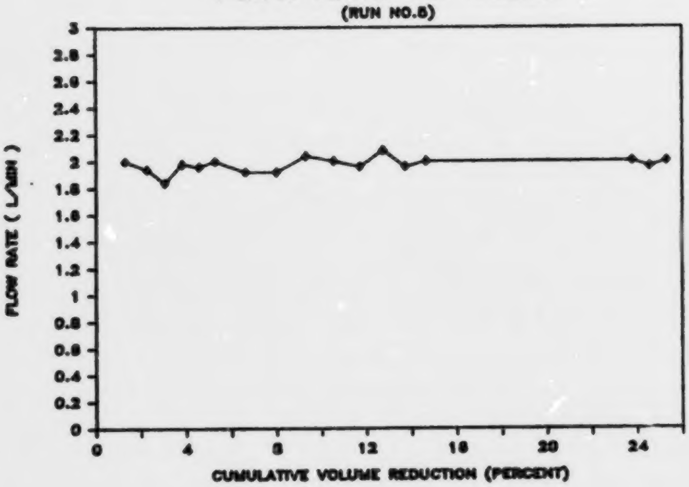
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORRECTED FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 17.00 | | | | | |
| 90.00 | 8.00 | 0.27 | 7.25 | 0.29 | 0.29 | 70.79 |
| 120.00 | 6.50 | 0.22 | 5.89 | 0.23 | 0.23 | |
| 150.00 | 6.00 | 0.20 | 5.43 | 0.22 | 0.22 | |
| 180.00 | 6.00 | 0.20 | 5.43 | 0.22 | 0.22 | |
| 210.00 | 6.00 | 0.20 | 5.43 | 0.22 | 0.22 | 67.98 |
| 240.00 | 6.00 | 0.20 | 5.43 | 0.22 | 0.22 | |
| 300.00 | 11.50 | 0.19 | 5.21 | 0.21 | 0.21 | |
| 360.00 | 13.00 | 0.22 | 5.89 | 0.23 | 0.23 | 66.58 |
| 420.00 | 13.50 | 0.23 | 6.11 | 0.24 | 0.24 | |
| 480.00 | 13.50 | 0.23 | 6.11 | 0.24 | 0.24 | 69.39 |
| 540.00 | 13.50 | 0.23 | 6.11 | 0.24 | 0.24 | |
| 600.00 | 12.00 | 0.20 | 5.43 | 0.22 | 0.22 | 67.98 |
| 660.00 | 12.00 | 0.20 | 5.43 | 0.22 | 0.22 | |
| 720.00 | 11.50 | 0.19 | 5.21 | 0.21 | 0.21 | 66.58 |
| 1380.00 | 127.00 | 0.19 | 5.23 | 0.21 | 0.21 | |
| 1440.00 | 11.50 | 0.19 | 5.21 | 0.21 | 0.21 | 67.98 |
| 1500.00 | 11.50 | 0.19 | 5.21 | 0.21 | 0.21 | |



pH VS VOLUME REDUCTION
(RUN NO.5)



TEMPERATURE VS VOLUME REDUCTION
(RUN NO.5)



FLOW RATE TO CELLS
(RUN NO.5)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 6

Temp. = 45°C pH = 9.5 Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CELLULOSE FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 1.54 | 2.15 | 2.25 | 1.95 | 2.43 | 1.67 | 0.47 |
| 120.00 | 2.75 | 1.65 | 1.72 | 1.51 | 1.89 | 1.44 | 0.41 |
| 150.00 | 4.03 | 1.70 | 1.77 | 1.53 | 2.00 | 1.58 | 0.45 |
| 180.00 | 5.08 | 1.36 | 1.46 | 1.24 | 1.64 | 1.30 | 0.40 |
| 210.00 | 6.08 | 1.29 | 1.39 | 1.18 | 1.56 | 1.26 | 0.38 |
| 240.00 | 7.04 | 1.17 | 1.32 | 1.12 | 1.54 | 1.26 | 0.40 |
| 300.00 | 8.94 | 1.23 | 1.32 | 1.08 | 1.41 | 1.24 | 0.41 |
| 360.00 | 10.59 | 1.08 | 1.14 | 0.91 | 1.30 | 1.06 | 0.35 |
| 420.00 | 12.17 | 1.04 | 1.09 | 0.81 | 1.22 | 1.04 | 0.35 |
| 480.00 | 13.76 | 1.03 | 1.09 | 0.92 | 1.20 | 1.02 | 0.35 |
| 540.00 | 15.25 | 0.98 | 1.03 | 0.80 | 1.13 | 0.95 | 0.34 |
| 600.00 | 16.75 | 1.03 | 1.04 | 0.81 | 1.10 | 0.97 | 0.36 |
| 660.00 | 18.23 | 1.01 | 1.02 | 0.79 | 1.10 | 0.93 | 0.36 |
| 720.00 | 19.69 | 1.01 | 1.01 | 0.78 | 1.09 | 0.91 | 0.38 |
| 1440.00 | 35.99 | 0.92 | 0.92 | 0.70 | 1.00 | 0.85 | 0.39 |
| 1500.00 | 37.27 | 0.80 | 0.85 | 0.65 | 0.95 | 0.81 | 0.41 |

## ANALYTICAL DATA FOR SCREENING TEST NO.6

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | C PERM | C %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 9.72 | 9.27 | 9.50 | 9.10 | | 8.98 | | 8.88 | | 8.91 | | 8.67 | | 8.81 | |
| COND | uHmos/cm | 1050 | 1075 | 1063 | 1075 | -1.2 | 800 | 24.7 | 590 | 44.5 | 610 | 42.6 | 290 | 72.7 | 545 | 48.7 |
| TURB | NTU | 980 | 2100 | 1540 | 1.15 | 99.9 | 0.92 | 99.9 | 0.63 | 100.0 | 0.85 | 99.9 | 0.22 | 100.0 | 0.58 | 100.0 |
| TOC | mg/L | 1400 | 1525 | 1463 | 139.5 | 90.5 | 32.0 | 97.8 | 58.5 | 96.0 | 73.0 | 95.0 | 35.5 | 97.6 | 52.0 | 96.4 |
| TDS | mg/L | 1040 | NA | 1040 | 845 | 18.8 | 515 | 50.5 | 460 | 55.8 | 440 | 57.7 | 245 | 76.4 | 415 | 60.1 |
| HARDNESS | mg/L | 8.47 | NA | 8.47 | 3.65 | 56.9 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 |
| DIS SIO2 | mg/L | 80.3 | NA | 80.3 | 58.4 | 27.3 | 60.8 | 24.3 | 47.0 | 41.5 | 58.4 | 27.3 | 49.7 | 38.1 | 58.2 | 27.5 |
| TSS | mg/L | 1610 | NA | 1610 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.6
% CUMULATIVE VOLUME REDUCTION
SEPTEMBER 6 1984 VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CELLULOSE PERM VOL (MLS) | TOTAL PERM VOL (MLS) | CONC pH | CONC TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 28.50 | 46.00 | 47.50 | 44.50 | 12.50 | 3.50 | 0.00 |  | 30.00 | 0.00 | 2.00 |
| 30.00 | 30.50 | 34.50 | 35.00 | 43.50 | 21.50 | 6.50 | 0.00 |  | 40.00 | 0.00 | 2.08 |
| 45.00 | 29.00 | 30.50 | 31.50 | 41.00 | 24.50 | 6.50 | 0.00 |  | 44.00 | 0.00 | 1.80 |
| 60.00 | 21.00 | 24.50 | 25.00 | 32.00 | 20.50 | 6.00 | 0.00 | 9.57 | 43.00 | 0.00 | 1.88 |
| 90.00 | 45.00 | 47.00 | 48.00 | 63.00 | 46.50 | 13.00 | 262.50 | 9.55 | 50.00 | 1.54 | 2.08 |
| 120.00 | 34.50 | 36.00 | 37.00 | 49.00 | 40.00 | 11.50 | 208.00 | 9.40 | 47.00 | 2.75 | 2.04 |
| 150.00 | 35.50 | 37.00 | 37.50 | 52.00 | 44.00 | 12.50 | 218.50 | 9.39 | 46.00 | 4.03 | 2.04 |
| 180.00 | 28.50 | 30.50 | 30.50 | 42.50 | 36.00 | 11.00 | 179.00 | 9.39 | 43.00 | 5.08 | 2.00 |
| 210.00 | 27.00 | 29.00 | 29.00 | 40.50 | 35.00 | 10.50 | 171.00 | 9.37 | 44.00 | 6.08 | 1.94 |
| 240.00 | 24.50 | 27.50 | 27.50 | 40.00 | 35.00 | 11.00 | 165.50 | 9.36 | 45.00 | 7.04 | 2.12 |
| 300.00 | 51.50 | 55.00 | 53.00 | 73.00 | 69.00 | 22.50 | 324.00 | 9.38 | 46.00 | 8.94 | 2.16 |
| 360.00 | 45.00 | 47.50 | 44.50 | 67.50 | 59.00 | 19.50 | 283.00 | 9.35 | 42.00 | 10.59 | 2.00 |
| 420.00 | 43.50 | 45.50 | 40.00 | 63.50 | 58.00 | 19.50 | 270.00 | 9.34 | 46.00 | 12.17 | 2.00 |
| 480.00 | 43.00 | 45.50 | 45.00 | 62.50 | 56.60 | 19.50 | 272.10 | 9.33 | 45.00 | 13.76 | 1.96 |
| 540.00 | 41.00 | 43.00 | 39.50 | 58.80 | 52.50 | 19.00 | 253.80 | 9.34 | 44.00 | 15.25 | 1.84 |
| 600.00 | 43.00 | 43.50 | 40.00 | 57.00 | 54.00 | 20.00 | 257.50 | 9.34 | 46.00 | 16.75 | 1.84 |
| 660.00 | 42.00 | 42.50 | 39.00 | 57.00 | 51.50 | 20.00 | 252.00 | 9.33 | 44.00 | 18.23 | 1.80 |
| 720.00 | 42.00 | 42.00 | 38.50 | 56.50 | 50.50 | 21.00 | 250.50 | 9.34 | 46.00 | 19.69 | 1.88 |
| 1440.00 | 460.00 | 460.00 | 414.00 | 624.00 | 566.00 | 263.00 | 2787.00 | 9.26 | 47.00 | 35.99 | 1.88 |
| 1500.00 | 33.50 | 35.50 | 32.00 | 49.50 | 45.00 | 23.00 | 218.50 | 9.27 | 49.00 | 37.27 | 2.20 |

RUN NO. VI
MEMBRANE: CHP
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 45.00 | 1.50 | 40.76 | 1.62 | 2.15 | 70.79 |
| 120.00 | 34.50 | 1.15 | 31.25 | 1.24 | 1.65 | |
| 150.00 | 35.50 | 1.18 | 32.15 | 1.28 | 1.70 | |
| 180.00 | 28.50 | 0.95 | 25.81 | 1.03 | 1.36 | |
| 210.00 | 27.00 | 0.90 | 24.45 | 0.97 | 1.29 | 69.39 |
| 240.00 | 24.50 | 0.82 | 22.19 | 0.88 | 1.17 | |
| 300.00 | 51.50 | 0.86 | 23.32 | 0.93 | 1.23 | |
| 360.00 | 45.00 | 0.75 | 20.38 | 0.81 | 1.08 | 69.39 |
| 420.00 | 43.50 | 0.73 | 19.70 | 0.78 | 1.04 | |
| 480.00 | 43.00 | 0.72 | 19.47 | 0.77 | 1.03 | 69.39 |
| 540.00 | 41.00 | 0.68 | 18.57 | 0.74 | 0.98 | |
| 600.00 | 43.00 | 0.72 | 19.47 | 0.77 | 1.03 | 75.01 |
| 660.00 | 42.00 | 0.70 | 19.02 | 0.76 | 1.01 | |
| 720.00 | 42.00 | 0.70 | 19.02 | 0.76 | 1.01 | 72.20 |
| 1440.00 | 460.00 | 0.64 | 17.36 | 0.69 | 0.92 | |
| 1500.00 | 33.50 | 0.56 | 15.17 | 0.60 | 0.80 | 72.20 |

RUN NO. VI
MEMBRANE: PVDF
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 133.50 | | | | | |
| 90.00 | 48.00 | 1.60 | 43.47 | 1.73 | 1.95 | 70.79 |
| 120.00 | 37.00 | 1.23 | 33.51 | 1.33 | 1.51 | |
| 150.00 | 37.50 | 1.25 | 33.96 | 1.35 | 1.53 | |
| 180.00 | 30.50 | 1.02 | 27.62 | 1.10 | 1.24 | |
| 210.00 | 29.00 | 0.97 | 29.89 | 1.04 | 1.18 | 73.60 |
| 240.00 | 27.50 | 0.92 | 24.91 | 0.99 | 1.12 | |
| 300.00 | 53.00 | 0.88 | 24.45 | 0.95 | 1.08 | |
| 360.00 | 44.50 | 0.74 | 22.64 | 0.80 | 0.91 | 72.20 |
| 420.00 | 40.00 | 0.67 | 21.74 | 0.72 | 0.81 | |
| 480.00 | 45.00 | 0.75 | 20.83 | 0.81 | 0.92 | 67.98 |
| 540.00 | 39.50 | 0.66 | 19.47 | 0.71 | 0.80 | |
| 600.00 | 40.00 | 0.67 | 18.57 | 0.72 | 0.81 | 72.20 |
| 660.00 | 39.00 | 0.65 | 17.66 | 0.70 | 0.79 | |
| 720.00 | 38.50 | 0.64 | 17.43 | 0.69 | 0.78 | 69.39 |
| 1440.00 | 414.00 | 0.58 | 15.62 | 0.62 | 0.70 | |
| 1500.00 | 32.00 | 0.53 | 14.49 | 0.58 | 0.65 | 75.01 |

RUN NO. VI
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2•D) | CORR FLUX RATE (M3/M2•D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 47.00 | 1.57 | 42.57 | 1.69 | 2.25 | 72.20 |
| 120.00 | 36.00 | 1.20 | 32.60 | 1.30 | 1.72 | |
| 150.00 | 37.00 | 1.23 | 33.51 | 1.33 | 1.77 | |
| 180.00 | 30.50 | 1.02 | 27.62 | 1.10 | 1.46 | |
| 210.00 | 29.00 | 0.97 | 26.26 | 1.04 | 1.39 | 70.79 |
| 240.00 | 27.50 | 0.92 | 24.91 | 0.99 | 1.32 | |
| 300.00 | 55.00 | 0.92 | 24.91 | 0.99 | 1.32 | |
| 360.00 | 47.50 | 0.79 | 21.51 | 0.86 | 1.14 | 72.20 |
| 420.00 | 45.50 | 0.76 | 20.60 | 0.82 | 1.09 | |
| 480.00 | 45.50 | 0.76 | 20.60 | 0.82 | 1.09 | 72.20 |
| 540.00 | 43.00 | 0.72 | 19.47 | 0.77 | 1.03 | |
| 600.00 | 43.50 | 0.73 | 19.70 | 0.78 | 1.04 | 73.60 |
| 660.00 | 42.50 | 0.71 | 19.25 | 0.77 | 1.02 | |
| 720.00 | 42.00 | 0.70 | 19.02 | 0.76 | 1.01 | 70.79 |
| 1440.00 | 460.00 | 0.64 | 17.36 | 0.69 | 0.92 | |
| 1500.00 | 35.50 | 0.59 | 16.08 | 0.64 | 0.85 | 72.20 |

RUN NO. V
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

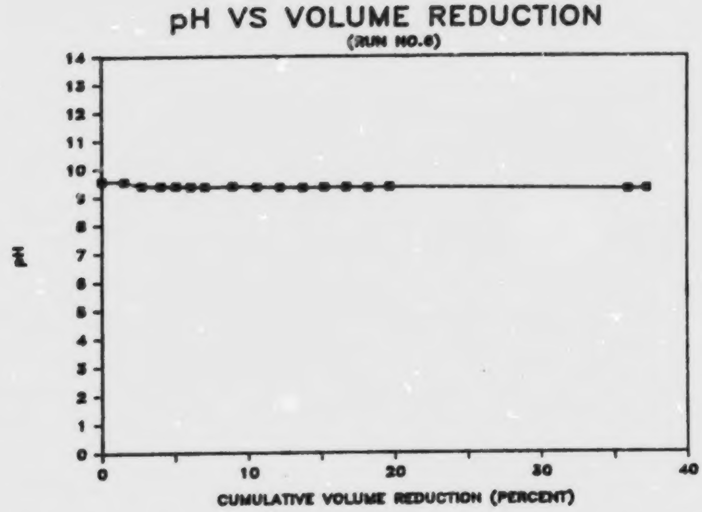
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2•D) | CORR FLUX RATE (M3/M2•D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 149.00 | | | | | |
| 90.00 | 63.00 | 2.10 | 57.06 | 2.27 | 2.43 | 70.79 |
| 120.00 | 49.00 | 1.63 | 44.38 | 1.76 | 1.89 | |
| 150.00 | 52.00 | 1.73 | 47.09 | 1.87 | 2.00 | |
| 180.00 | 42.50 | 1.42 | 38.49 | 1.53 | 1.64 | |
| 210.00 | 40.50 | 1.35 | 36.68 | 1.46 | 1.56 | 67.98 |
| 240.00 | 40.00 | 1.33 | 36.23 | 1.44 | 1.54 | |
| 300.00 | 73.00 | 1.22 | 33.06 | 1.31 | 1.41 | |
| 360.00 | 67.50 | 1.13 | 30.57 | 1.22 | 1.30 | 70.79 |
| 420.00 | 63.50 | 1.06 | 28.75 | 1.14 | 1.22 | |
| 480.00 | 62.50 | 1.04 | 28.30 | 1.13 | 1.20 | 70.79 |
| 540.00 | 58.80 | 0.98 | 26.63 | 1.06 | 1.13 | |
| 600.00 | 57.00 | 0.95 | 25.81 | 1.03 | 1.10 | 73.60 |
| 660.00 | 57.00 | 0.95 | 25.81 | 1.03 | 1.10 | |
| 720.00 | 56.50 | 0.94 | 25.59 | 1.02 | 1.09 | 72.20 |
| 1440.00 | 624.00 | 0.87 | 23.55 | 0.94 | 1.00 | |
| 1500.00 | 49.50 | 0.83 | 22.42 | 0.89 | 0.95 | 70.79 |

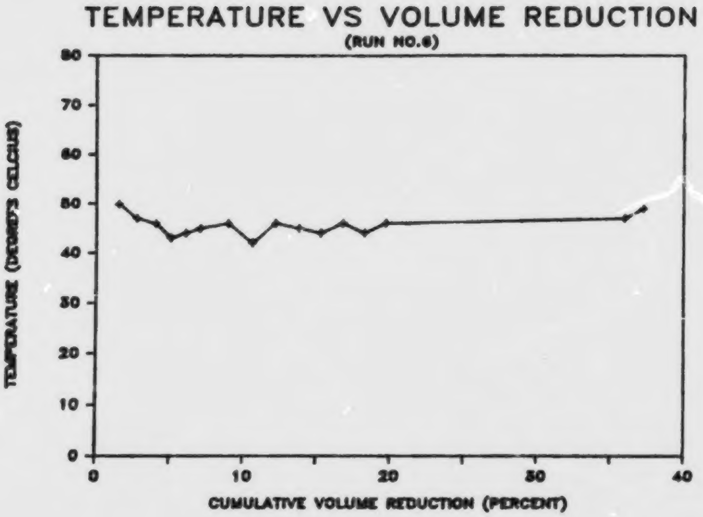
RUN NO. VI
MEMBRANE: TFC
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

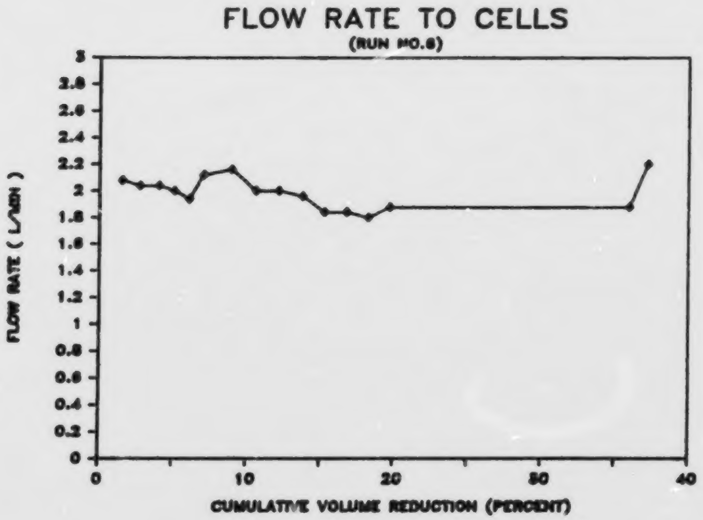
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 59.00 | | | | | |
| 90.00 | 46.50 | 1.55 | 42.11 | 1.67 | 1.67 | 70.79 |
| 120.00 | 40.00 | 1.33 | 36.23 | 1.44 | 1.44 | |
| 150.00 | 44.00 | 1.47 | 39.85 | 1.58 | 1.58 | |
| 180.00 | 36.00 | 1.20 | 32.60 | 1.30 | 1.30 | |
| 210.00 | 35.00 | 1.17 | 31.70 | 1.26 | 1.26 | 72.20 |
| 240.00 | 35.00 | 1.17 | 31.70 | 1.26 | 1.26 | |
| 300.00 | 69.00 | 1.15 | 31.25 | 1.24 | 1.24 | |
| 360.00 | 59.00 | 0.98 | 26.72 | 1.06 | 1.06 | 72.20 |
| 420.00 | 58.00 | 0.97 | 26.26 | 1.04 | 1.04 | |
| 480.00 | 56.60 | 0.94 | 25.63 | 1.02 | 1.02 | 75.01 |
| 540.00 | 52.50 | 0.88 | 23.77 | 0.95 | 0.95 | |
| 600.00 | 54.00 | 0.90 | 24.45 | 0.97 | 0.97 | 72.20 |
| 660.00 | 51.50 | 0.86 | 23.32 | 0.93 | 0.93 | |
| 720.00 | 50.50 | 0.84 | 22.87 | 0.91 | 0.91 | 73.60 |
| 1440.00 | 566.00 | 0.79 | 21.36 | 0.85 | 0.85 | |
| 1500.00 | 45.00 | 0.75 | 20.38 | 0.81 | 0.81 | 73.60 |

RUN NO. VI
MEMBRANE: CELLULOSE
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 17.00 | | | | | |
| 90.00 | 13.00 | 0.43 | 11.77 | 0.47 | 0.47 | 69.39 |
| 120.00 | 11.50 | 0.38 | 10.42 | 0.41 | 0.41 | |
| 150.00 | 12.50 | 0.42 | 11.32 | 0.45 | 0.45 | |
| 180.00 | 11.00 | 0.37 | 9.96 | 0.40 | 0.40 | |
| 210.00 | 10.50 | 0.35 | 9.51 | 0.38 | 0.38 | 70.79 |
| 240.00 | 11.00 | 0.37 | 9.96 | 0.40 | 0.40 | |
| 300.00 | 22.50 | 0.38 | 10.19 | 0.41 | 0.41 | |
| 360.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.35 | 70.79 |
| 420.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.35 | |
| 480.00 | 19.50 | 0.33 | 8.83 | 0.35 | 0.35 | 73.60 |
| 540.00 | 19.00 | 0.32 | 8.60 | 0.34 | 0.34 | |
| 600.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.36 | 70.79 |
| 660.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.36 | |
| 720.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.38 | 69.39 |
| 1440.00 | 263.00 | 0.37 | 9.92 | 0.39 | 0.39 | |
| 1500.00 | 23.00 | 0.38 | 10.42 | 0.41 | 0.41 | 70.79 |


pH VS VOLUME REDUCTION
(RUN NO.6)
pH
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
10
20
30
40
CUMULATIVE VOLUME REDUCTION (PERCENT)


TEMPERATURE VS VOLUME REDUCTION
(RUN NO.6)
TEMPERATURE (DEGREES CELCIUS)
0
10
20
30
40
50
60
70
80
0
10
20
30
40
CUMULATIVE VOLUME REDUCTION (PERCENT)


FLOW RATE TO CELLS
(RUN NO.6)
FLOW RATE ( L/MIN )
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
0
10
20
30
40
CUMULATIVE VOLUME REDUCTION (PERCENT)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 7

Temp. = 65°C pH = as is (7.5 - 8.0) Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CHP FLUX RATE M3/M2·D | PS FLUX RATE M3/M2·D | PVDF FLUX RATE M3/M2·D | CA FLUX RATE M3/M2·D | TFC FLUX RATE M3/M2·D | CHP2 FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 0.00 | | | | | | |
| 90.00 | 1.88 | 1.44 | 2.49 | 2.16 | 2.81 | 2.20 | 1.89 |
| 120.00 | 3.45 | 1.36 | 2.01 | 1.73 | 2.33 | 1.93 | 1.51 |
| 150.00 | 4.80 | 1.10 | 1.75 | 1.51 | 1.93 | 1.69 | 1.31 |
| 180.00 | 5.97 | 0.96 | 1.53 | 1.32 | 1.64 | 1.48 | 1.15 |
| 210.00 | 7.12 | 0.96 | 1.53 | 1.30 | 1.58 | 1.48 | 1.13 |
| 240.00 | 8.44 | 1.15 | 1.75 | 1.48 | 1.75 | 1.69 | 1.30 |
| 300.00 | 10.92 | 1.15 | 1.68 | 1.39 | 1.58 | 1.59 | 1.22 |
| 360.00 | 12.64 | 0.79 | 1.17 | 0.97 | 1.11 | 1.08 | 0.84 |
| 420.00 | 14.62 | 0.96 | 1.38 | 1.11 | 1.24 | 1.24 | 0.95 |
| 480.00 | 16.37 | 0.78 | 1.23 | 1.00 | 1.12 | 1.11 | 0.86 |
| 540.00 | 17.84 | 0.63 | 0.95 | 0.79 | 0.94 | 0.95 | 0.77 |
| 600.00 | 19.47 | 0.74 | 1.09 | 0.89 | 1.03 | 1.05 | 0.85 |
| 660.00 | 21.12 | 0.79 | 1.13 | 0.89 | 1.02 | 1.04 | 0.85 |
| 720.00 | 22.73 | 0.78 | 1.11 | 0.88 | 0.98 | 1.02 | 0.83 |
| 1380.00 | 39.81 | 0.84 | 1.07 | 0.85 | 0.92 | 0.95 | 0.79 |
| 1440.00 | 41.30 | 0.85 | 0.96 | 0.83 | 0.89 | 0.90 | 0.77 |
| 1500.00 | 42.58 | 0.67 | 0.78 | 0.71 | 0.79 | 0.79 | 0.69 |

## ANALYTICAL DATA FOR SCREENING TEST NO.7

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | CHP PERM | CHP %REJ | CA PERM | CA %REJ | PS PERM | PS %REJ | CHP PERM | CHP %REJ | TFC PERM | TFC %REJ | PVDF PERM | PVDF %REJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH |  | 8.15 | 9.48 | 8.82 | 8.63 |  | 8.93 |  | 8.81 |  | 8.94 |  | 8.9 |  | 8.85 |  |
| COND | uHmos/cm | 975 | 1400 | 1188 | 560 | 52.8 | 630 | 46.9 | 580 | 51.2 | 620 | 47.8 | 375 | 68.4 | 590 | 50.3 |
| TURB | NTU | 520 | 4300 | 2410 | 0.54 | 100.0 | 0.43 | 100.0 | 0.41 | 100.0 | 0.40 | 100.0 | 0.29 | 100.0 | 0.5 | 100.0 |
| TOC | mg/L | 2050 | 3788 | 2919 | 58.5 | 98.0 | 69.5 | 97.6 | 47.0 | 98.4 | 59.5 | 98.0 | 28.0 | 99.0 | 53.0 | 98.2 |
| TDS | mg/L | 987.5 | NA | 987.5 | 382 | 61.3 | 561 | 43.2 | 398.5 | 59.6 | 469.5 | 52.5 | 261.5 | 73.5 | 406.5 | 58.8 |
| HARDNESS | mg/L | 21.67 | NA | 21.67 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 | <0.15 | 100.0 |
| DIS SIO2 | mg/L | 78.6 | NA | 78.6 | 64.3 | 18.2 | 64.2 | 18.3 | 63.3 | 19.5 | 61.9 | 21.2 | 64.2 | 18.3 | 63.7 | 19.0 |
| TSS | mg/L | 1616 | NA | 1616 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

RUN NO.7
% VOLUME REDUCTION
SEPTEMBER 17 1984 VOLUME OF FEED 17100.00 MLS

| TIME (MIN) | CHP1 PERM VOL (MLS) | PS PERM VOL (MLS) | PVDF PERM VOL (MLS) | CA PERM VOL (MLS) | TFC PERM VOL (MLS) | CHP2 PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 12.00 | 37.00 | 38.50 | 33.00 | 14.00 | 39.50 | 0.00 | | | 0.00 | 2.00 |
| 30.00 | 13.50 | 26.50 | 28.00 | 36.00 | 22.50 | 35.00 | 0.00 | | | 0.00 | 2.08 |
| 45.00 | 13.00 | 25.00 | 27.00 | 36.00 | 24.50 | 30.00 | 0.00 | | | 0.00 | 1.80 |
| 60.00 | 13.50 | 24.00 | 26.50 | 35.50 | 27.00 | 27.50 | 0.00 | | 68.00 | 0.00 | 1.88 |
| 90.00 | 30.00 | 52.00 | 53.00 | 73.00 | 61.00 | 52.50 | 321.50 | 8.15 | 61.00 | 1.88 | 2.08 |
| 120.00 | 28.50 | 42.00 | 42.50 | 60.50 | 53.50 | 42.00 | 269.00 | | 67.00 | 3.45 | 2.04 |
| 150.00 | 23.00 | 36.50 | 37.00 | 50.00 | 47.00 | 36.30 | 229.80 | | 58.00 | 4.80 | 2.04 |
| 180.00 | 20.00 | 32.00 | 32.50 | 42.50 | 41.00 | 32.00 | 200.00 | | 66.00 | 5.97 | 2.00 |
| 210.00 | 20.00 | 32.00 | 32.00 | 41.00 | 41.00 | 31.50 | 197.50 | | 68.00 | 7.12 | 1.94 |
| 240.00 | 24.00 | 36.50 | 36.50 | 45.50 | 47.00 | 36.00 | 225.50 | | 69.00 | 8.44 | 2.12 |
| 300.00 | 48.00 | 70.00 | 68.50 | 82.00 | 88.50 | 67.50 | 424.50 | | 59.00 | 10.92 | 2.16 |
| 360.00 | 33.00 | 49.00 | 47.50 | 57.50 | 60.00 | 46.50 | 293.50 | | 65.00 | 12.64 | 2.00 |
| 420.00 | 40.00 | 57.50 | 54.50 | 64.50 | 69.00 | 53.00 | 338.50 | | 61.00 | 14.62 | 2.00 |
| 480.00 | 32.50 | 51.50 | 49.00 | 58.00 | 61.50 | 47.50 | 300.00 | | 60.00 | 16.37 | 1.96 |
| 540.00 | 26.50 | 39.50 | 39.00 | 49.00 | 53.00 | 43.00 | 250.00 | | 67.00 | 17.84 | 1.84 |
| 600.00 | 31.00 | 45.50 | 44.00 | 53.50 | 58.50 | 47.00 | 279.50 | | 64.00 | 19.47 | 1.84 |
| 660.00 | 33.00 | 47.00 | 44.00 | 53.00 | 58.00 | 47.00 | 282.00 | | 63.00 | 21.12 | 1.80 |
| 720.00 | 32.50 | 46.50 | 43.50 | 51.00 | 56.50 | 46.00 | 276.00 | | | 22.73 | 1.88 |
| 1380.00 | 385.00 | 490.00 | 457.00 | 528.00 | 578.00 | 482.00 | 2920.00 | | | 39.81 | 1.88 |
| 1440.00 | 35.50 | 40.00 | 41.00 | 46.00 | 50.00 | 42.50 | 255.00 | | 60.00 | 41.30 | 2.20 |
| 1500.00 | 28.00 | 32.50 | 35.00 | 41.00 | 44.00 | 38.50 | 219.00 | 9.48 | 60.00 | 42.58 | 2.20 |

RUN NO. VII
MEMBRANE: CHP1
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | | | | | | |
| 90.00 | 30.00 | 1.00 | 27.17 | 1.08 | 1.44 | |
| 120.00 | 28.50 | 0.95 | 25.81 | 1.03 | 1.36 | 67.39 |
| 150.00 | 23.00 | 0.77 | 20.83 | 0.83 | 1.10 | |
| 180.00 | 20.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 210.00 | 20.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 240.00 | 24.00 | 0.80 | 21.74 | 0.86 | 1.15 | 69.39 |
| 300.00 | 48.00 | 0.80 | 21.74 | 0.86 | 1.15 | |
| 360.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.79 | 70.79 |
| 420.00 | 40.00 | 0.67 | 18.11 | 0.72 | 0.96 | |
| 480.00 | 32.50 | 0.54 | 14.72 | 0.59 | 0.78 | 66.58 |
| 540.00 | 26.50 | 0.44 | 12.00 | 0.48 | 0.63 | |
| 600.00 | 31.00 | 0.52 | 14.04 | 0.56 | 0.74 | 69.39 |
| 660.00 | 33.00 | 0.55 | 14.94 | 0.59 | 0.79 | |
| 720.00 | 32.50 | 0.54 | 14.72 | 0.59 | 0.78 | 67.98 |
| 1380.00 | 385.00 | 0.58 | 15.85 | 0.63 | 0.84 | |
| 1440.00 | 35.50 | 0.59 | 16.08 | 0.64 | 0.85 | 65.17 |
| 1500.00 | 28.00 | 0.47 | 12.68 | 0.50 | 0.67 | |

RUN NO. VII
MEMBRANE: PVDF
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 133.50 | | | | | |
| 90.00 | 53.00 | 1.77 | 48.00 | 1.91 | 2.16 | |
| 120.00 | 42.50 | 1.42 | 38.49 | 1.53 | 1.73 | 65.17 |
| 150.00 | 37.00 | 1.23 | 33.51 | 1.33 | 1.51 | |
| 180.00 | 32.50 | 1.08 | 29.43 | 1.17 | 1.32 | |
| 210.00 | 32.00 | 1.07 | 29.89 | 1.15 | 1.30 | |
| 240.00 | 36.50 | 1.22 | 24.91 | 1.31 | 1.48 | 67.98 |
| 300.00 | 68.50 | 1.14 | 24.45 | 1.23 | 1.39 | |
| 360.00 | 47.50 | 0.79 | 22.64 | 0.86 | 0.97 | 73.60 |
| 420.00 | 54.50 | 0.91 | 21.74 | 0.98 | 1.11 | |
| 480.00 | 49.00 | 0.82 | 20.83 | 0.88 | 1.00 | 70.79 |
| 540.00 | 39.00 | 0.65 | 19.47 | 0.70 | 0.79 | |
| 600.00 | 44.00 | 0.73 | 18.57 | 0.79 | 0.89 | 63.77 |
| 660.00 | 44.00 | 0.73 | 19.92 | 0.79 | 0.89 | |
| 720.00 | 43.50 | 0.73 | 19.70 | 0.78 | 0.88 | 67.98 |
| 1380.00 | 457.00 | 0.69 | 18.81 | 0.75 | 0.85 | |
| 1440.00 | 41.00 | 0.68 | 18.57 | 0.74 | 0.83 | 67.98 |
| 1500.00 | 35.00 | 0.58 | 15.85 | 0.63 | 0.71 | |

RUN NO. VII
MEMBRANE: PS
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 118.50 | | | | | |
| 90.00 | 52.00 | 1.73 | 47.09 | 1.87 | 2.49 | |
| 120.00 | 42.00 | 1.40 | 38.04 | 1.51 | 2.01 | 63.77 |
| 150.00 | 36.50 | 1.22 | 33.06 | 1.31 | 1.75 | |
| 180.00 | 32.00 | 1.07 | 28.98 | 1.15 | 1.53 | |
| 210.00 | 32.00 | 1.07 | 28.98 | 1.15 | 1.53 | |
| 240.00 | 36.50 | 1.22 | 33.06 | 1.31 | 1.75 | 67.98 |
| 300.00 | 70.00 | 1.17 | 31.70 | 1.26 | 1.68 | |
| 360.00 | 49.00 | 0.82 | 22.19 | 0.88 | 1.17 | 73.60 |
| 420.00 | 57.50 | 0.96 | 26.04 | 1.04 | 1.38 | |
| 480.00 | 51.50 | 0.86 | 23.32 | 0.93 | 1.23 | 67.98 |
| 540.00 | 39.50 | 0.66 | 17.89 | 0.71 | 0.95 | |
| 600.00 | 45.50 | 0.76 | 20.60 | 0.82 | 1.09 | 63.77 |
| 660.00 | 47.00 | 0.78 | 21.28 | 0.85 | 1.13 | |
| 720.00 | 46.50 | 0.78 | 21.06 | 0.84 | 1.11 | 67.98 |
| 1380.00 | 490.00 | 0.74 | 20.17 | 0.80 | 1.07 | |
| 1440.00 | 40.00 | 0.67 | 18.11 | 0.72 | 0.96 | 67.98 |
| 1500.00 | 32.50 | 0.54 | 14.72 | 0.59 | 0.78 | |

RUN NO. VII
MEMBRANE: CA
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

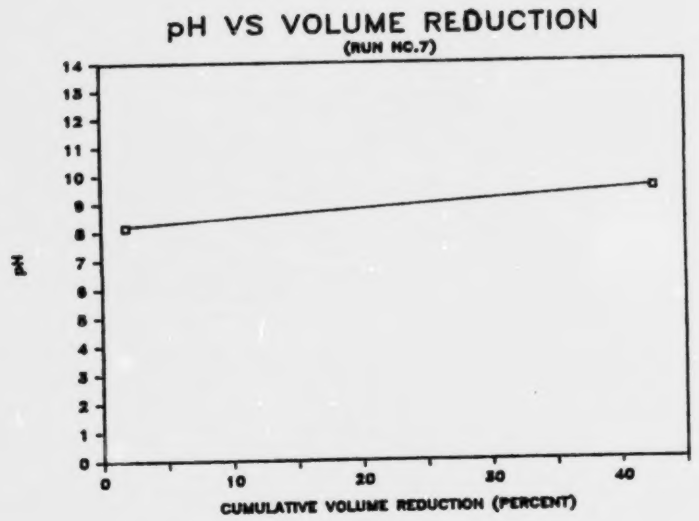
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 149.00 | | | | | |
| 90.00 | 73.00 | 2.43 | 66.11 | 2.63 | 2.81 | |
| 120.00 | 60.50 | 2.02 | 54.79 | 2.18 | 2.33 | 67.98 |
| 150.00 | 50.00 | 1.67 | 45.28 | 1.80 | 1.93 | |
| 180.00 | 42.50 | 1.42 | 38.49 | 1.53 | 1.64 | |
| 210.00 | 41.00 | 1.37 | 37.13 | 1.48 | 1.58 | |
| 240.00 | 45.50 | 1.52 | 41.21 | 1.64 | 1.75 | 69.39 |
| 300.00 | 82.00 | 1.37 | 37.13 | 1.48 | 1.58 | |
| 360.00 | 57.50 | 0.96 | 26.04 | 1.04 | 1.11 | 70.79 |
| 420.00 | 64.50 | 1.08 | 29.21 | 1.16 | 1.24 | |
| 480.00 | 58.00 | 0.97 | 26.26 | 1.04 | 1.12 | 67.98 |
| 540.00 | 49.00 | 0.82 | 22.19 | 0.88 | 0.94 | |
| 600.00 | 53.50 | 0.89 | 24.23 | 0.96 | 1.03 | 67.98 |
| 660.00 | 53.00 | 0.88 | 24.00 | 0.95 | 1.02 | |
| 720.00 | 51.00 | 0.85 | 23.09 | 0.92 | 0.98 | 67.98 |
| 1380.00 | 528.00 | 0.80 | 21.74 | 0.86 | 0.92 | |
| 1440.00 | 46.00 | 0.77 | 20.83 | 0.83 | 0.89 | 67.98 |
| 1500.00 | 41.00 | 0.68 | 18.57 | 0.74 | 0.79 | |

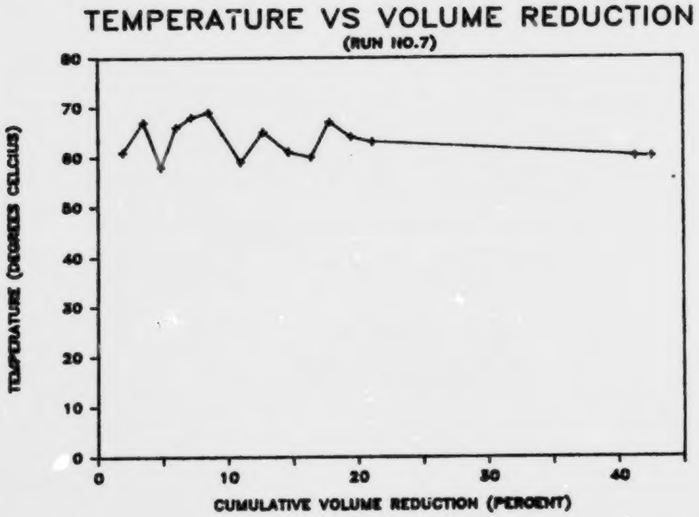
RUN NO. VII
MEMBRANE: TFC
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

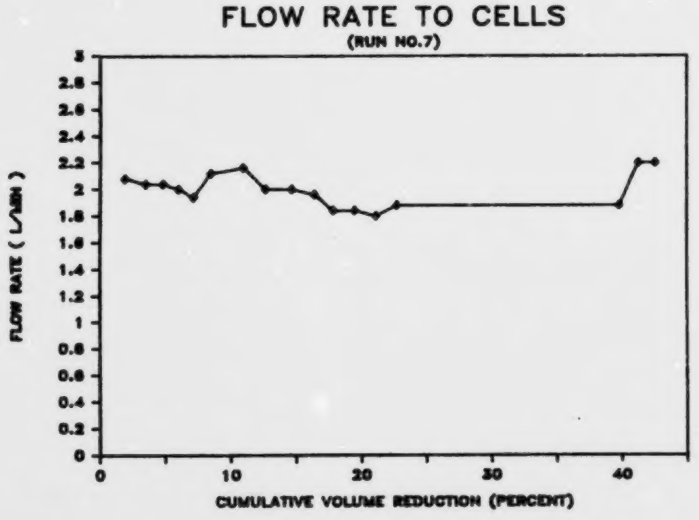
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 59.00 | | | | | |
| 90.00 | 61.00 | 2.03 | 55.25 | 2.20 | 2.20 | |
| 120.00 | 53.50 | 1.78 | 48.45 | 1.93 | 1.93 | 63.77 |
| 150.00 | 47.00 | 1.57 | 42.57 | 1.69 | 1.69 | |
| 180.00 | 41.00 | 1.37 | 37.13 | 1.48 | 1.48 | |
| 210.00 | 41.00 | 1.37 | 37.13 | 1.48 | 1.48 | |
| 240.00 | 47.00 | 1.57 | 42.57 | 1.69 | 1.69 | 53.93 |
| 300.00 | 88.50 | 1.48 | 40.08 | 1.59 | 1.59 | |
| 360.00 | 60.00 | 1.00 | 27.17 | 1.08 | 1.08 | 70.79 |
| 420.00 | 69.00 | 1.15 | 31.25 | 1.24 | 1.24 | |
| 480.00 | 61.50 | 1.03 | 27.85 | 1.11 | 1.11 | 72.20 |
| 540.00 | 53.00 | 0.88 | 24.00 | 0.95 | 0.95 | |
| 600.00 | 58.50 | 0.98 | 26.49 | 1.05 | 1.05 | 70.79 |
| 660.00 | 58.00 | 0.97 | 26.26 | 1.04 | 1.04 | |
| 720.00 | 56.50 | 0.94 | 25.59 | 1.02 | 1.02 | 70.79 |
| 1380.00 | 578.00 | 0.88 | 23.79 | 0.95 | 0.95 | |
| 1440.00 | 50.00 | 0.83 | 22.64 | 0.90 | 0.90 | 63.77 |
| 1500.00 | 44.00 | 0.73 | 19.92 | 0.79 | 0.79 | |

RUN NO. VII
MEMBRANE: CHP2
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | SURFACE TENSION (DYNES/CM) |
|---|---|---|---|---|---|---|
| 60.00 | 17.00 | | | | | |
| 90.00 | 52.50 | 1.75 | 47.55 | 1.89 | 1.89 | |
| 120.00 | 42.00 | 1.40 | 38.04 | 1.51 | 1.51 | 69.39 |
| 150.00 | 36.30 | 1.21 | 32.88 | 1.31 | 1.31 | |
| 180.00 | 32.00 | 1.07 | 28.98 | 1.15 | 1.15 | |
| 210.00 | 31.50 | 1.05 | 28.53 | 1.13 | 1.13 | |
| 240.00 | 36.00 | 1.20 | 32.60 | 1.30 | 1.30 | 69.39 |
| 300.00 | 67.50 | 1.13 | 30.57 | 1.22 | 1.22 | |
| 360.00 | 46.50 | 0.78 | 21.06 | 0.84 | 0.84 | 73.60 |
| 420.00 | 53.00 | 0.88 | 24.00 | 0.95 | 0.95 | |
| 480.00 | 47.50 | 0.79 | 21.51 | 0.86 | 0.86 | 67.98 |
| 540.00 | 43.00 | 0.72 | 19.47 | 0.77 | 0.77 | |
| 600.00 | 47.00 | 0.78 | 21.28 | 0.85 | 0.85 | 59.55 |
| 660.00 | 47.00 | 0.78 | 21.28 | 0.85 | 0.85 | |
| 720.00 | 46.00 | 0.77 | 20.83 | 0.83 | 0.83 | 69.39 |
| 1380.00 | 482.00 | 0.73 | 19.84 | 0.79 | 0.79 | |
| 1440.00 | 42.50 | 0.71 | 19.25 | 0.77 | 0.77 | 63.77 |
| 1500.00 | 38.50 | 0.64 | 17.43 | 0.69 | 0.69 | |


pH VS VOLUME REDUCTION
(RUN NO.7)


TEMPERATURE VS VOLUME REDUCTION
(RUN NO.7)


FLOW RATE TO CELLS
(RUN NO.7)

## FLUX RATES FOR EMULSION SCREENING TEST NO. 8

Temp. = 65°C pH = as is (7.5 - 8.0) Pressure = 100 - 150 psi

| TIME (MIN) | CUMULATIVE VOLUME REDUCTION (%) | CELL1 PS FLUX RATE M3/M2·D | CELL2 PS FLUX RATE M3/M2·D | CELL3 PS FLUX RATE M3/M2·D | CELL4 PS FLUX RATE M3/M2·D | CELL5 PS FLUX RATE M3/M2·D | CELL6 PS FLUX RATE M3/M2·D |
|---|---|---|---|---|---|---|---|
| 60.00 | 1.58 | 2.51 | 2.84 | 1.84 | 2.03 | 1.71 | 1.82 |
| 120.00 | 2.78 | 1.72 | 1.80 | 1.42 | 1.51 | 1.47 | 1.46 |
| 180.00 | 3.87 | 1.53 | 1.60 | 1.30 | 1.34 | 1.38 | 1.33 |
| 240.00 | 4.89 | 1.51 | 1.51 | 1.15 | 1.26 | 1.27 | 1.25 |
| 1260.00 | 11.78 | 0.54 | 0.58 | 0.46 | 0.49 | 0.54 | 0.52 |
| 1380.00 | 12.94 | 0.87 | 0.89 | 0.64 | 0.71 | 0.74 | 0.70 |
| 1500.00 | 14.05 | 0.80 | 0.84 | 0.61 | 0.68 | 0.70 | 0.68 |
| 1620.00 | 15.15 | 0.83 | 0.86 | 0.59 | 0.69 | 0.65 | 0.68 |
| 2640.00 | 21.78 | 0.58 | 0.63 | 0.38 | 0.51 | 0.43 | 0.52 |
| 2760.00 | 22.45 | 0.57 | 0.60 | 0.30 | 0.45 | 0.32 | 0.44 |
| 2880.00 | 23.11 | 0.56 | 0.60 | 0.28 | 0.41 | 0.31 | 0.45 |
| 3000.00 | 23.78 | 0.57 | 0.62 | 0.28 | 0.44 | 0.30 | 0.42 |
| 3120.00 | 24.33 | 0.49 | 0.52 | 0.23 | 0.38 | 0.24 | 0.35 |
| 4500.00 | 30.45 | 0.49 | 0.27 | 0.39 | 0.36 | 0.22 | 0.33 |
| 4538.00 | 30.61 | 0.49 | 0.25 | 0.40 | 0.32 | 0.23 | 0.31 |
| 5520.00 | 35.23 | 0.58 | 0.62 | 0.17 | 0.41 | 0.23 | 0.28 |
| 5640.00 | 35.76 | 0.57 | 0.61 | 0.16 | 0.39 | 0.22 | 0.24 |
| 5760.00 | 36.25 | 0.53 | 0.56 | 0.14 | 0.36 | 0.20 | 0.21 |
| 5940.00 | 36.86 | 0.44 | 0.47 | 0.11 | 0.30 | 0.16 | 0.17 |
| 6000.00 | 37.07 | 0.48 | 0.50 | 0.13 | 0.22 | 0.18 | 0.20 |
| 7405.00 | 40.92 | 0.37 | 0.11 | 0.29 | 0.15 | 0.12 | 0.22 |
| 7435.00 | 40.99 | 0.29 | 0.10 | 0.25 | 0.12 | 0.10 | 0.18 |
| 8760.00 | 44.54 | 0.37 | 0.39 | 0.08 | 0.25 | 0.12 | 0.13 |
| 8820.00 | 44.72 | 0.42 | 0.43 | 0.08 | 0.26 | 0.13 | 0.14 |
| 9900.00 | 47.95 | 0.42 | 0.45 | 0.08 | 0.27 | 0.13 | 0.13 |
| 10020.00 | 48.35 | 0.50 | 0.53 | 0.11 | 0.32 | 0.07 | 0.16 |

## ANALYTICAL DATA FOR SCREENING TEST NO.8

| PARAMETER | UNITS | INIT FEED | FINAL FEED | MEAN FEED | PS COM PERM | PS %REJ |
|---|---|---|---|---|---|---|
| pH | | 7.4 | 9.15 | 8.28 | 7.88 | |
| COND | uHmos/cm | 1000 | 1450 | 1225 | 580 | 52.7 |
| TURB | NTU | 1000 | 2350 | 1675 | 2.30 | 99.9 |
| TOC | mg/L | 158 | 240 | 199 | 46.0 | 76.9 |
| TDS | mg/L | 1154 | 492 | 1154 | NA | 100.0 |
| HARDNESS | mg/L | 4.75 | NA | 4.75 | <0.15 | 100.0 |
| DIS SIO2 | mg/L | NA | NA | NA | NA | NA |
| TSS | mg/L | NA | NA | NA | NA | NA |

RUN NO.8
% CUMULATIVE VOLUME REDUCTION
SEPTEMBER 17 1984  VOLUME OF FEED  38000.00 MLS

| TIME (MIN) | CELL 1 PERM VOL (MLS) | CELL 2 PERM VOL (MLS) | CELL 3 PERM VOL (MLS) | CELL 4 PERM VOL (MLS) | CELL 5 PERM VOL (MLS) | CELL6 PERM VOL (MLS) | TOTAL PERM VOL (MLS) | FEED pH | FEED TEMP (C) | CUM VOL RED (%) | FLOW TO CELLS (L/MIN) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | | | | |
| 60.00 | 105.00 | 103.00 | 100.00 | 89.00 | 102.00 | 101.00 | 600.00 | | 24.00 | 1.58 | 2.16 |
| 120.00 | 72.00 | 75.00 | 74.00 | 76.50 | 79.00 | 81.00 | 457.50 | | 39.00 | 2.78 | 2.00 |
| 180.00 | 64.00 | 67.00 | 66.00 | 71.50 | 72.00 | 74.00 | 414.50 | | | 3.87 | 2.12 |
| 240.00 | 63.00 | 63.00 | 62.00 | 66.00 | 64.00 | 69.50 | 387.50 | | | 4.89 | 2.08 |
| 1260.00 | 385.00 | 412.00 | 410.00 | 477.00 | 438.00 | 493.00 | 2615.00 | | 39.00 | 11.78 | 2.04 |
| 1380.00 | 72.50 | 74.50 | 70.00 | 77.00 | 71.00 | 78.00 | 443.00 | | 54.00 | 12.94 | 1.96 |
| 1500.00 | 66.50 | 70.50 | 66.50 | 72.50 | 68.00 | 76.00 | 420.00 | | 65.00 | 14.05 | 2.04 |
| 1620.00 | 69.50 | 72.00 | 68.00 | 68.00 | 65.00 | 76.00 | 418.50 | | 65.00 | 15.15 | 2.00 |
| 2640.00 | 414.00 | 450.00 | 428.00 | 376.00 | 359.00 | 492.00 | 2519.00 | | 51.00 | 21.78 | 2.16 |
| 2760.00 | 47.50 | 50.00 | 44.00 | 33.00 | 33.00 | 48.50 | 256.00 | | 63.00 | 22.45 | 1.80 |
| 2880.00 | 47.00 | 50.50 | 40.50 | 32.00 | 31.50 | 50.00 | 251.50 | | 63.00 | 23.11 | 2.00 |
| 3000.00 | 48.00 | 52.00 | 43.00 | 31.00 | 31.00 | 47.00 | 252.00 | | 66.00 | 23.78 | 1.80 |
| 3120.00 | 41.00 | 43.50 | 37.00 | 24.50 | 25.00 | 39.00 | 210.00 | | 57.00 | 24.33 | 1.84 |
| 4500.00 | 468.00 | 256.00 | 412.00 | 262.00 | 500.00 | 427.00 | 2325.00 | | 64.00 | 30.45 | 2.08 |
| 4538.00 | 13.00 | 6.50 | 10.00 | 7.50 | 14.00 | 11.00 | 62.00 | | 68.00 | 30.61 | 2.00 |
| 5520.00 | 398.00 | 421.00 | 333.00 | 193.00 | 157.00 | 252.00 | 1754.00 | | 60.00 | 35.23 | 2.00 |
| 5640.00 | 48.00 | 51.00 | 38.50 | 23.00 | 17.50 | 26.50 | 204.50 | | 56.00 | 35.76 | 2.06 |
| 5760.00 | 44.00 | 46.50 | 35.00 | 20.50 | 15.50 | 23.50 | 185.00 | | 67.00 | 36.25 | 1.94 |
| 5940.00 | 55.50 | 59.50 | 44.00 | 25.50 | 19.00 | 29.00 | 232.50 | | 65.00 | 36.86 | 1.92 |
| 6000.00 | 20.00 | 21.00 | 11.00 | 9.50 | 7.00 | 11.00 | 79.50 | | 69.00 | 37.07 | 2.00 |
| 7405.00 | 364.00 | 108.00 | 174.00 | 146.00 | 383.00 | 288.00 | 1463.00 | | 59.00 | 40.92 | 1.80 |
| 7435.00 | 6.00 | 2.00 | 3.00 | 2.50 | 7.00 | 5.00 | 25.50 | | 59.00 | 40.99 | 2.00 |
| 8760.00 | 340.00 | 362.00 | 266.00 | 133.00 | 94.00 | 154.00 | 1349.00 | | 60.00 | 44.54 | 2.00 |
| 8820.00 | 17.50 | 18.00 | 13.00 | 7.00 | 4.60 | 7.50 | 67.60 | | 52.00 | 44.72 | 2.00 |
| 9900.00 | 319.00 | 338.00 | 241.00 | 117.00 | 82.00 | 131.00 | 1228.00 | | 60.00 | 47.95 | 2.00 |
| 10020.00 | 41.50 | 44.50 | 31.50 | 7.00 | 12.00 | 18.00 | 154.50 | | 60.00 | 48.35 | 2.00 |

RUN NO. VIII
MEMBRANE: PS1
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 105.00 | 1.75 | 47.55 | 1.89 | 2.51 |
| 120.00 | 72.00 | 1.20 | 32.60 | 1.30 | 1.72 |
| 180.00 | 64.00 | 1.07 | 28.98 | 1.15 | 1.53 |
| 240.00 | 63.00 | 1.05 | 28.53 | 1.13 | 1.51 |
| 1260.00 | 385.00 | 0.38 | 10.26 | 0.41 | 0.54 |
| 1380.00 | 72.50 | 0.60 | 16.42 | 0.65 | 0.87 |
| 1500.00 | 66.50 | 0.55 | 15.06 | 0.60 | 0.80 |
| 1620.00 | 69.50 | 0.58 | 15.74 | 0.63 | 0.83 |
| 2640.00 | 414.00 | 0.41 | 11.03 | 0.44 | 0.58 |
| 2760.00 | 47.50 | 0.40 | 10.75 | 0.43 | 0.57 |
| 2880.00 | 47.00 | 0.39 | 10.64 | 0.42 | 0.56 |
| 3000.00 | 48.00 | 0.40 | 10.87 | 0.43 | 0.57 |
| 3120.00 | 41.00 | 0.34 | 9.28 | 0.37 | 0.49 |
| 4500.00 | 468.00 | 0.34 | 9.21 | 0.37 | 0.49 |
| 4538.00 | 13.00 | 0.34 | 9.30 | 0.37 | 0.49 |
| 5520.00 | 398.00 | 0.41 | 11.01 | 0.44 | 0.58 |
| 5640.00 | 48.00 | 0.40 | 10.87 | 0.43 | 0.57 |
| 5760.00 | 44.00 | 0.37 | 9.96 | 0.40 | 0.53 |
| 5940.00 | 55.50 | 0.31 | 8.38 | 0.33 | 0.44 |
| 6000.00 | 20.00 | 0.33 | 9.06 | 0.36 | 0.48 |
| 7405.00 | 364.00 | 0.26 | 7.04 | 0.28 | 0.37 |
| 7435.00 | 6.00 | 0.20 | 5.43 | 0.22 | 0.29 |
| 8760.00 | 340.00 | 0.26 | 6.97 | 0.28 | 0.37 |
| 8820.00 | 17.50 | 0.29 | 7.92 | 0.32 | 0.42 |
| 9900.00 | 319.00 | 0.30 | 8.03 | 0.32 | 0.42 |
| 10020.00 | 41.50 | 0.35 | 9.40 | 0.37 | 0.50 |

RUN NO. VIII
MEMBRANE: PS2
PRESSURE: 100.00 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 118.50 | 1.98 | 53.66 | 2.13 | 2.84 |
| 120.00 | 75.00 | 1.25 | 33.96 | 1.35 | 1.80 |
| 180.00 | 67.00 | 1.12 | 30.34 | 1.21 | 1.60 |
| 240.00 | 63.00 | 1.05 | 28.53 | 1.13 | 1.51 |
| 1260.00 | 412.00 | 0.40 | 10.97 | 0.44 | 0.58 |
| 1380.00 | 74.50 | 0.62 | 16.87 | 0.67 | 0.89 |
| 1500.00 | 70.50 | 0.59 | 15.96 | 0.63 | 0.84 |
| 1620.00 | 72.00 | 0.60 | 16.30 | 0.65 | 0.86 |
| 2640.00 | 450.00 | 0.44 | 11.99 | 0.48 | 0.63 |
| 2760.00 | 50.00 | 0.42 | 11.32 | 0.45 | 0.60 |
| 2880.00 | 50.50 | 0.42 | 11.43 | 0.45 | 0.60 |
| 3000.00 | 52.00 | 0.43 | 11.77 | 0.47 | 0.62 |
| 3120.00 | 43.50 | 0.36 | 9.85 | 0.39 | 0.52 |
| 4500.00 | 256.00 | 0.19 | 5.04 | 0.20 | 0.27 |
| 4538.00 | 6.50 | 0.17 | 4.65 | 0.18 | 0.25 |
| 5520.00 | 421.00 | 0.43 | 11.65 | 0.46 | 0.62 |
| 5640.00 | 51.00 | 0.43 | 11.55 | 0.46 | 0.61 |
| 5760.00 | 46.50 | 0.39 | 10.53 | 0.42 | 0.56 |
| 5940.00 | 59.50 | 0.33 | 8.98 | 0.36 | 0.47 |
| 6000.00 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 |
| 7405.00 | 108.00 | 0.08 | 2.09 | 0.08 | 0.11 |
| 7435.00 | 2.00 | 0.07 | 1.81 | 0.07 | 0.10 |
| 8760.00 | 362.00 | 0.27 | 7.42 | 0.30 | 0.39 |
| 8820.00 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 |
| 9900.00 | 338.00 | 0.31 | 8.50 | 0.34 | 0.45 |
| 10020.00 | 44.50 | 0.37 | 10.08 | 0.40 | 0.53 |

RUN NO. VIII
MEMBRANE: PS3
PRESSURE= 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 102.00 | 1.70 | 46.19 | 1.84 | 1.84 |
| 120.00 | 79.00 | 1.32 | 35.77 | 1.42 | 1.42 |
| 180.00 | 72.00 | 1.20 | 32.60 | 1.30 | 1.30 |
| 240.00 | 64.00 | 1.07 | 28.98 | 1.15 | 1.15 |
| 1260.00 | 438.00 | 0.43 | 11.67 | 0.46 | 0.46 |
| 1380.00 | 71.00 | 0.59 | 16.08 | 0.64 | 0.64 |
| 1500.00 | 68.00 | 0.57 | 15.40 | 0.61 | 0.61 |
| 1620.00 | 65.00 | 0.54 | 14.72 | 0.59 | 0.59 |
| 2640.00 | 359.00 | 0.35 | 9.56 | 0.38 | 0.38 |
| 2760.00 | 33.00 | 0.28 | 7.47 | 0.30 | 0.30 |
| 2880.00 | 31.50 | 0.26 | 7.13 | 0.28 | 0.28 |
| 3000.00 | 31.00 | 0.26 | 7.02 | 0.28 | 0.28 |
| 3120.00 | 25.00 | 0.21 | 5.66 | 0.23 | 0.23 |
| 4500.00 | 500.00 | 0.36 | 9.84 | 0.39 | 0.39 |
| 4538.00 | 14.00 | 0.37 | 10.01 | 0.40 | 0.40 |
| 5520.00 | 157.00 | 0.16 | 4.34 | 0.17 | 0.17 |
| 5640.00 | 17.50 | 0.15 | 3.96 | 0.16 | 0.16 |
| 5760.00 | 15.50 | 0.13 | 3.51 | 0.14 | 0.14 |
| 5940.00 | 19.00 | 0.11 | 2.87 | 0.11 | 0.11 |
| 6000.00 | 7.00 | 0.12 | 3.17 | 0.13 | 0.13 |
| 7405.00 | 383.00 | 0.27 | 7.41 | 0.29 | 0.29 |
| 7435.00 | 7.00 | 0.23 | 6.34 | 0.25 | 0.25 |
| 8760.00 | 94.00 | 0.07 | 1.93 | 0.08 | 0.08 |
| 8820.00 | 4.60 | 0.08 | 2.08 | 0.08 | 0.08 |
| 9900.00 | 82.00 | 0.08 | 2.06 | 0.08 | 0.08 |
| 10020.00 | 12.00 | 0.10 | 2.72 | 0.11 | 0.11 |

RUN NO. VIII
MEMBRANE: PS4
PRESSURE: 130.00 psi
PRESSURE CORRECTION FACTOR 1.13

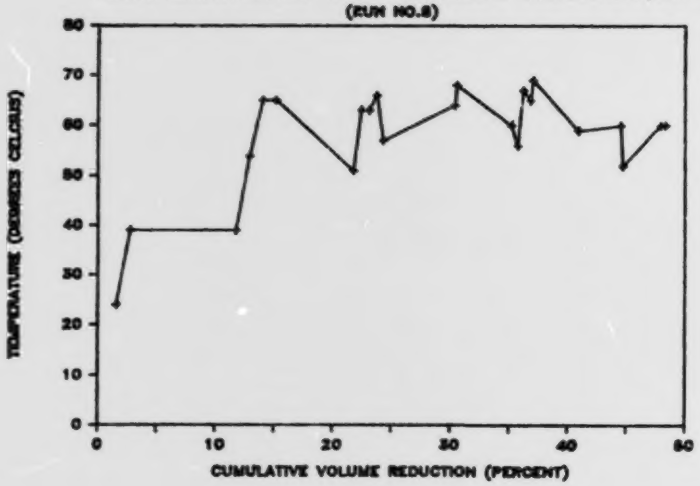
| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 100.00 | 1.67 | 45.28 | 1.80 | 2.03 |
| 120.00 | 74.00 | 1.23 | 33.51 | 1.33 | 1.51 |
| 180.00 | 66.00 | 1.10 | 29.89 | 1.19 | 1.34 |
| 240.00 | 62.00 | 1.03 | 28.08 | 1.12 | 1.26 |
| 1260.00 | 410.00 | 0.40 | 10.92 | 0.43 | 0.49 |
| 1380.00 | 70.00 | 0.58 | 15.85 | 0.63 | 0.71 |
| 1500.00 | 66.50 | 0.55 | 15.06 | 0.60 | 0.68 |
| 1620.00 | 68.00 | 0.57 | 15.40 | 0.61 | 0.69 |
| 2640.00 | 428.00 | 0.42 | 29.89 | 0.45 | 0.51 |
| 2760.00 | 44.00 | 0.37 | 24.91 | 0.40 | 0.45 |
| 2880.00 | 40.50 | 0.34 | 24.45 | 0.36 | 0.41 |
| 3000.00 | 43.00 | 0.36 | 22.64 | 0.39 | 0.44 |
| 3120.00 | 37.00 | 0.31 | 21.74 | 0.33 | 0.38 |
| 4500.00 | 412.00 | 0.30 | 20.83 | 0.32 | 0.36 |
| 4538.00 | 10.00 | 0.26 | 19.47 | 0.28 | 0.32 |
| 5520.00 | 333.00 | 0.34 | 18.57 | 0.37 | 0.41 |
| 5640.00 | 38.50 | 0.32 | 8.72 | 0.35 | 0.39 |
| 5760.00 | 35.00 | 0.29 | 7.92 | 0.32 | 0.36 |
| 5940.00 | 44.00 | 0.24 | 6.64 | 0.26 | 0.30 |
| 6000.00 | 11.00 | 0.18 | 4.98 | 0.20 | 0.22 |
| 7405.00 | 174.00 | 0.12 | 3.36 | 0.13 | 0.15 |
| 7435.00 | 3.00 | 0.10 | 2.72 | 0.11 | 0.12 |
| 8760.00 | 266.00 | 0.20 | 5.45 | 0.22 | 0.25 |
| 8820.00 | 13.00 | 0.22 | 5.89 | 0.23 | 0.26 |
| 9900.00 | 241.00 | 0.22 | 6.06 | 0.24 | 0.27 |
| 10020.00 | 31.50 | 0.26 | 7.13 | 0.28 | 0.32 |

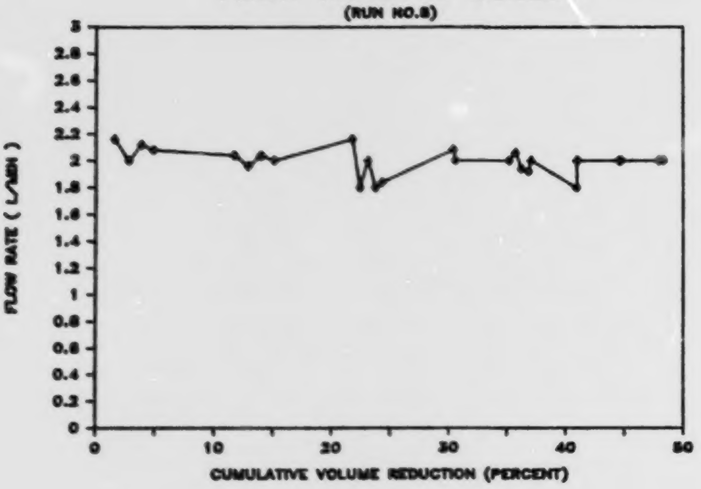
RUN NO. VIII
MEMBRANE: PS5
PRESSURE: 140.00 psi
PRESSURE CORRECTION FACTOR 1.07

| TIME (MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 89.00 | 1.48 | 40.30 | 1.60 | 1.71 |
| 120.00 | 76.50 | 1.28 | 34.64 | 1.38 | 1.47 |
| 180.00 | 71.50 | 1.19 | 32.38 | 1.29 | 1.38 |
| 240.00 | 66.00 | 1.10 | 29.89 | 1.19 | 1.27 |
| 1260.00 | 477.00 | 0.47 | 12.71 | 0.51 | 0.54 |
| 1380.00 | 77.00 | 0.64 | 17.43 | 0.69 | 0.74 |
| 1500.00 | 72.50 | 0.60 | 16.42 | 0.65 | 0.70 |
| 1620.00 | 68.00 | 0.57 | 15.40 | 0.61 | 0.65 |
| 2640.00 | 376.00 | 0.37 | 10.02 | 0.40 | 0.43 |
| 2760.00 | 33.00 | 0.28 | 7.47 | 0.30 | 0.32 |
| 2880.00 | 32.00 | 0.27 | 7.25 | 0.29 | 0.31 |
| 3000.00 | 31.00 | 0.26 | 7.02 | 0.28 | 0.30 |
| 3120.00 | 24.50 | 0.20 | 5.55 | 0.22 | 0.24 |
| 4500.00 | 262.00 | 0.19 | 5.16 | 0.21 | 0.22 |
| 4538.00 | 7.50 | 0.20 | 5.36 | 0.21 | 0.23 |
| 5520.00 | 193.00 | 0.20 | 5.34 | 0.21 | 0.23 |
| 5640.00 | 23.00 | 0.19 | 5.21 | 0.21 | 0.22 |
| 5760.00 | 20.50 | 0.17 | 4.64 | 0.18 | 0.20 |
| 5940.00 | 25.50 | 0.14 | 3.85 | 0.15 | 0.16 |
| 6000.00 | 9.50 | 0.16 | 4.30 | 0.17 | 0.18 |
| 7405.00 | 146.00 | 0.10 | 2.82 | 0.11 | 0.12 |
| 7435.00 | 2.50 | 0.08 | 2.26 | 0.09 | 0.10 |
| 8760.00 | 133.00 | 0.10 | 2.73 | 0.11 | 0.12 |
| 8820.00 | 7.00 | 0.12 | 3.17 | 0.13 | 0.13 |
| 9900.00 | 117.00 | 0.11 | 2.94 | 0.12 | 0.13 |
| 10020.00 | 7.00 | 0.06 | 1.58 | 0.06 | 0.07 |

RUN NO. VIII
MEMBRANE: PS6
PRESSURE: 150.00 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME<br>(MIN) | PERMEATE VOLUME (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) |
|---|---|---|---|---|---|
| 60.00 | 101.00 | 1.68 | 45.74 | 1.82 | 1.82 |
| 120.00 | 81.00 | 1.35 | 36.68 | 1.46 | 1.46 |
| 180.00 | 74.00 | 1.23 | 33.51 | 1.33 | 1.33 |
| 240.00 | 69.50 | 1.16 | 31.47 | 1.25 | 1.25 |
| 1260.00 | 493.00 | 0.48 | 13.13 | 0.52 | 0.52 |
| 1380.00 | 78.00 | 0.65 | 17.66 | 0.70 | 0.70 |
| 1500.00 | 76.00 | 0.63 | 17.21 | 0.68 | 0.68 |
| 1620.00 | 76.00 | 0.63 | 17.21 | 0.68 | 0.68 |
| 2640.00 | 492.00 | 0.48 | 13.11 | 0.52 | 0.52 |
| 2760.00 | 48.50 | 0.40 | 10.98 | 0.44 | 0.44 |
| 2880.00 | 50.00 | 0.42 | 11.32 | 0.45 | 0.45 |
| 3000.00 | 47.00 | 0.39 | 10.64 | 0.42 | 0.42 |
| 3120.00 | 39.00 | 0.33 | 8.83 | 0.35 | 0.35 |
| 4500.00 | 427.00 | 0.31 | 8.41 | 0.33 | 0.33 |
| 4538.00 | 11.00 | 0.29 | 7.87 | 0.31 | 0.31 |
| 5520.00 | 252.00 | 0.26 | 6.97 | 0.28 | 0.28 |
| 5640.00 | 26.50 | 0.22 | 6.00 | 0.24 | 0.24 |
| 5760.00 | 23.50 | 0.20 | 5.32 | 0.21 | 0.21 |
| 5940.00 | 29.00 | 0.16 | 4.38 | 0.17 | 0.17 |
| 6000.00 | 11.00 | 0.18 | 4.98 | 0.20 | 0.20 |
| 7405.00 | 288.00 | 0.20 | 5.57 | 0.22 | 0.22 |
| 7435.00 | 5.00 | 0.17 | 4.53 | 0.18 | 0.18 |
| 8760.00 | 154.00 | 0.12 | 3.16 | 0.13 | 0.13 |
| 8820.00 | 7.50 | 0.13 | 3.40 | 0.14 | 0.14 |
| 9900.00 | 131.00 | 0.12 | 3.30 | 0.13 | 0.13 |
| 10020.00 | 18.00 | 0.15 | 4.08 | 0.16 | 0.16 |


TEMPERATURE VS VOLUME REDUCTION
(RUN NO.8)


FLOW RATE TO CELLS
(RUN NO.8)

```
          CORRELATION AND MULTIPLE LINEAR REGRESSION RESULTS

                   CHP FLUX RATES AND CONDITIONS


 1                 .55 0 -1
 2                 .79 0 0
 3                 .48 -1 -1
 4                 .45 -1 0
 5                 .55 1 -1
 6                 .99 1 0
 7                 .81 0 1
                    CORRELATION OF CHP DATA

COL A     MEAN           STD DEV      COL B   COVARIANCE      CORRELATION
-----  -----------     -----------    -----  -----------      -----------

 1      .66             .2037156       2      8.714287E-02     .6112233
                                       3      7.857143E-02     .5952591
 2      0               .8164966       3      0                0
 3     -.2857143        .7559289

        # OF ROWS =  7


                    MULTIPLE LINEAR REGRESSION

TERM              COEFFICIENT      T-TEST
----              -----------    ----------

B 0                .7058333      0
B 1                .1525         2.343627
B 2                .1604167      2.282416

                        SUM SQ        DEG FR         MEAN SQ
                        ------        ------         -------

DUE TO REGRESSION       .1812542       2              9.062709E-02
ABOUT REGRESSION        6.774584E-02   4              1.693646E-02
TOTAL                   .249           6              .0415

R-SQUARED         .7279284
F-TEST            5.351006
```

```
                PS FLUX RATES AND CONDITIONS


1              .7 0 -1
2              .78 0 0
3              .18 -1 -1
4              .88 -1 0
5              .57 1 -1
6              .99 1 0
7              1.10 0 1

                 CORRELATION FOR PS DATA

COL A     MEAN          STD DEV      COL B   COVARIANCE     CORRELATION
-----  -----------    -----------    -----  -----------    -----------

 1       .7428571      .3047795       2      7.142858E-02   .3348719
                                      3      .1622449       .8215823
 2      0              .8164966       3      0              0
 3     -.2857143       .7559289

          # OF ROWS =  7


                  MULTIPLE LINEAR REGRESSION FOR PS DATA

TERM           COEFFICIENT      T-TEST
----           -----------    ----------

B 0            .8375          0
B 1            .125           1.45164
B 2            .33125         3.561488

                    SUM SQ       DEG FR      MEAN SQ
                    ------       ------      -------

DUE TO REGRESSION   .4387054       2          .2193527
ABOUT REGRESSION    .1186375       4          2.965938E-02
TOTAL               .5573429       6          9.289048E-02

R-SQUARED      .7871373
F-TEST         7.395729
```

```
                TFC FLUX RATES AND CONDITIONS


 1              .63 0 -1
 2              .75 0 0
 3              .39 -1 -1
 4              .35 -1 0
 5              .5 1 -1
 6              .9 1 0
 7              1.05 0 1

                CORRELATION OF TFC DATA

COL A    MEAN            STD DEV       COL B   COVARIANCE      CORRELATION
-----    -----------     -----------   -----   -----------     -----------

  1       .6528571        .2623429       2      9.428571E-02    .5135338
                                         3      .1193878        .7023545
  2      0                .8164966       3      0               0
  3      -.2857143        .7559289

         # OF ROWS =  7


                MULTIPLE LINEAR REGRESSION OF TFC DATA

TERM            COEFFICIENT      T-TEST
----            -----------     ----------

B 0             .7225          0
B 1             .165           2.08359
B 2             .24375         2.849703

                         SUM SQ        DEG FR       MEAN SQ
                         ------        ------       -------

DUE TO REGRESSION       .3126053        2            .1563027
ABOUT REGRESSION        .1003375        4            2.508438E-02
TOTAL                   .4129428        6            6.882381E-02

R-SQUARED       .7570184
F-TEST          6.231076
```

```
                 CELLULOSE FLUX RATES AND CONDITIONS


1             .22 0 -1
2             .25 0 0
3             .26 -1 -1
4             .28 -1 0
5             .21 1 -1
6             .38 1 0
                   CORRELATION OF CELLULOSE DATA

COL A     MEAN            STD DEV       COL B    COVARIANCE     CORRELATION
-----  -----------     -----------      -----   -----------     -----------

  1     .2666667       6.120991E-02      2       8.333336E-03    .1826558
                                         3       1.833334E-02    .6562065
  2     0              .8944272          3       0               0
  3    -.5             .5477226

        # OF ROWS =  6


                   MULTIPLE LINEAR REGRESSION OF CELLULOSE DATA

TERM             COEFFICIENT      T-TEST
----             -----------     ----------

B 0              .3033334        0
B 1              .0125          .4321134
B 2              7.333334E-02   1.552404
                            SUM SQ         DEG FR          MEAN SQ
                            ------         ------          -------

DUE TO REGRESSION        8.691668E-03      2            4.345834E-03
ABOUT REGRESSION         1.004167E-02      3            3.347222E-03
TOTAL                    1.873333E-02      5            3.746667E-03

R-SQUARED        .463968
F-TEST           1.298341
```

```
                 CA FLUX RATES AND CONDITIONS



1               .59 0 -1
2               .74 0 0
3               .51 -1 -1
4               .88 -1 0
5               .76 1 -1
6               1.07 1 0
7               1.03 0 1

                   CORRELATION OF CA DATA

COL A     MEAN          STD DEV      COL B   COVARIANCE      CORRELATION
-----  -----------    -----------    -----   -----------     -----------

 1       .7971429       .2103737       2     6.285715E-02   .426929
                                       3     .1091837       .8009993
 2      0               .8164966       3     0              0
 3     -.2857143        .7559289

           # OF ROWS =  7


                 (D5): MULTIPLE LINEAR REGRESSION OF CA DATA

TERM            COEFFICIENT      T-TEST
----            -----------    ----------

B 0             .8608334       0
B 1             .11            2.034535
B 2             .2229167       3.81717

                         SUM SQ        DEG FR       MEAN SQ
                         ------        ------       -------

DUE TO REGRESSION        .2187721        2           .109386
ABOUT REGRESSION         4.677086E-02    4           1.169271E-02
TOTAL                    .2655429        6           4.425715E-02

R-SQUARED       .823867
F-TEST          9.355059
```

```
                PVDF FLUX RATES AND CONDITIONS



1              .59 0 -1
2              .71 0 0
3              .39 -1 -1
4              .65 -1 0
5              .45 1 -1
6              .77 1 0
7              .89 0 1

                 CORRELATION DATA FOR PVDF MEMBRANE

COL A    MEAN          STD DEV      COL B   COVARIANCE     CORRELATION
-----  -----------   -----------    -----  -----------    -----------

 1      .6357143      .1757705       2      2.571429E-02   .2090359
                                     3      .1044898       .9174739
 2      0             .8164966       3      0              0
 3     -.2857143      .7559289

        # OF ROWS =  7


                  MULTIPLE LINEAR REGRESSION FOR PVDF

TERM           COEFFICIENT      T-TEST
----           -----------    ----------

B 0            .6966666        0
B 1            .045            1.235274
B 2            .2133334        5.421709

                      SUM SQ        DEG FR        MEAN SQ
                      ------        ------        -------

DUE TO REGRESSION     .1641381        2           8.206905E-02
ABOUT REGRESSION      2.123334E-02    4           5.308334E-03
TOTAL                 .1853714        6           3.089524E-02

R-SQUARED      .8854552
F-TEST         15.46042
```

FLUX RATE CHANGE WITH pH

| MEMBRANE | MEAN FLUX RATE AT LOW pH (5.5) | MEAN FLUX RATE AT NORMAL pH (7.5-8.0) | MEAN FLUX RATE AT HIGH pH (9.5) |
|---|---|---|---|
| CHP | 0.69 | 0.91 | 1.02 |
| PS | 0.58 | 1.09 | 1.10 |
| TFC | 0.57 | 0.87 | 0.95 |
| CELLULOSE | 0.29 | 0.29 | 0.31 |
| CA | 1.02 | 0.99 | 1.29 |
| PVDF | 0.80 | 0.98 | 0.91 |

# APPENDIX E

# RESULTS OF CONCENTRATION AND STABILITY TEST

BATCH CONCENTRATION EXPERIMENT
% CUMULATIVE VOLUME REDUCTION
OCTOBER 3 17 1984
VOLUME OF FEED 30 L

| TIME | CHP | TFC | PS | TFC | PS | CHP | PVDF LRG CELLS | TOTAL | CUM TOT | VOLUME REDUC. | CUM VOLUME REDUC. | FEED RATE | FEED TEMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | PERM VOL | PERM VOL | PERM VOL | PERM VOL | PERM VOL | PERM VOL | PERM VOL | PERM VOL | PERM VOL |  |  |  |  |
| (HRS) | (MLS) | (MLS) | (MLS) | (MLS) | (MLS) | (MLS) | (MLS) | (MLS) | (MLS) | % | % | L/MIN | C |
| 1.00 | 189.00 | 78.00 | 117.00 | 62.00 | 121.00 | 115.00 |  | 682.00 | 682.00 | 2.27 | 2.27 | 2.16 | 48 |
| 3.67 | 350.00 | 280.00 | 270.00 | 255.00 | 304.00 | 300.00 |  | 1759.00 | 2441.00 | 5.86 | 8.14 |  |  |
| 17.00 | 750.00 | 655.00 | 574.00 | 527.00 | 569.00 | 444.00 |  | 3519.00 | 5960.00 | 11.73 | 19.87 |  | 58 |
| 18.00 | 42.00 | 29.00 | 18.00 | 15.00 | 16.00 | 10.00 | 3237.00 | 3367.00 | 9327.00 | 11.22 | 31.09 | 1.96 | 63 |
| 19.00 | 38.00 | 29.00 | 19.00 | 17.00 | 18.00 | 11.00 | 150.00 | 282.00 | 9609.00 | 0.94 | 32.03 | 2.00 | 64 |
| 20.00 | 46.00 | 31.00 | 20.00 | 19.00 | 19.00 | 12.00 | 1490.00 | 1637.00 | 11246.00 | 5.46 | 37.49 | 2.32 | 66 |
| 22.00 | 79.00 | 59.00 | 35.00 | 36.00 | 36.00 | 25.00 | 2741.00 | 3011.00 | 14257.00 | 10.04 | 47.52 | 2.16 | 63 |
| 23.00 | 34.00 | 28.00 | 17.00 | 18.00 | 18.00 | 13.00 | 1275.00 | 1403.00 | 15660.00 | 4.68 | 52.20 | 2.16 | 62 |
| 24.00 | 34.00 | 28.00 | 16.00 | 17.00 | 18.00 | 13.00 | 1260.00 | 1386.00 | 17046.00 | 4.62 | 56.82 | 2.20 | 60 |
| 25.00 | 35.00 | 26.00 | 16.00 | 17.00 | 18.00 | 13.00 | 910.00 | 1035.00 | 18081.00 | 3.45 | 60.27 |  | 62 |
| 41.00 | 496.00 | 426.00 | 246.00 | 290.00 | 337.00 | 259.00 |  | 2054.00 | 20135.00 | 6.85 | 67.12 | 1.80 | 66 |
| 42.00 | 30.00 | 29.00 | 17.00 | 19.00 | 24.00 | 18.00 | 1375.00 | 1512.00 | 21647.00 | 5.04 | 72.16 | 2.20 | 62 |
| 43.00 | 29.00 | 30.00 | 17.00 | 20.00 | 26.00 | 20.00 | 1390.00 | 1532.00 | 23179.00 | 5.11 | 77.26 | 1.96 | 64 |
| 44.00 | 27.00 | 28.00 | 16.00 | 20.00 | 26.00 | 21.00 | 1330.00 | 1468.00 | 24647.00 | 4.89 | 82.16 | 1.60 | 65 |
| 46.00 | 30.00 | 30.00 | 16.00 | 20.00 | 29.00 | 23.00 | 1845.00 | 1993.00 | 26640.00 | 6.64 | 88.80 | 1.60 | 55 |
| 47.00 | 6.00 | 6.00 | 3.00 | 4.00 | 5.00 | 5.00 | 360.00 | 389.00 | 27029.00 | 1.30 | 90.10 | 1.40 |  |

CHP CELL1
PRESSURE: 150 psi
PRESSURE CORRECTION FACTOR 1.00

| TIME (MIN) | PERM VOLUME (MLS) | PERM RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | CUM VOL RED (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 189.00 | 3.15 | 85.59 | 3.40 | 3.40 | 2.27 |
| 220.2 | 350.00 | 2.18 | 59.36 | 2.36 | 2.36 | 8.14 |
| 1020.0 | 750.00 | 0.94 | 25.48 | 1.01 | 1.01 | 19.87 |
| 1080.0 | 42.00 | 0.70 | 19.02 | 0.76 | 0.76 | 31.09 |
| 1140.0 | 38.00 | 0.63 | 17.21 | 0.68 | 0.68 | 32.03 |
| 1200.0 | 46.00 | 0.77 | 20.83 | 0.83 | 0.83 | 37.49 |
| 1320.0 | 79.00 | 0.66 | 17.89 | 0.71 | 0.71 | 47.52 |
| 1380.0 | 34.00 | 0.57 | 15.40 | 0.61 | 0.61 | 52.20 |
| 1440.0 | 34.00 | 0.57 | 15.40 | 0.61 | 0.61 | 56.82 |
| 1500.0 | 35.00 | 0.58 | 15.85 | 0.63 | 0.63 | 60.27 |
| 2460.0 | 496.00 | 0.52 | 14.04 | 0.56 | 0.56 | 67.12 |
| 2520.0 | 30.00 | 0.50 | 13.59 | 0.54 | 0.54 | 72.16 |
| 2580.0 | 29.00 | 0.48 | 13.13 | 0.52 | 0.52 | 77.26 |
| 2640.0 | 27.00 | 0.45 | 12.23 | 0.49 | 0.49 | 82.16 |
| 2760.0 | 30.00 | 0.25 | 6.79 | 0.27 | 0.27 | 88.80 |
| 2820.0 | 6.00 | 0.10 | 2.72 | 0.11 | 0.11 | 90.10 |

TFC CELL 2
PRESSURE: 150 psi
PRESSURE CORRECTION FACTOR 1.00

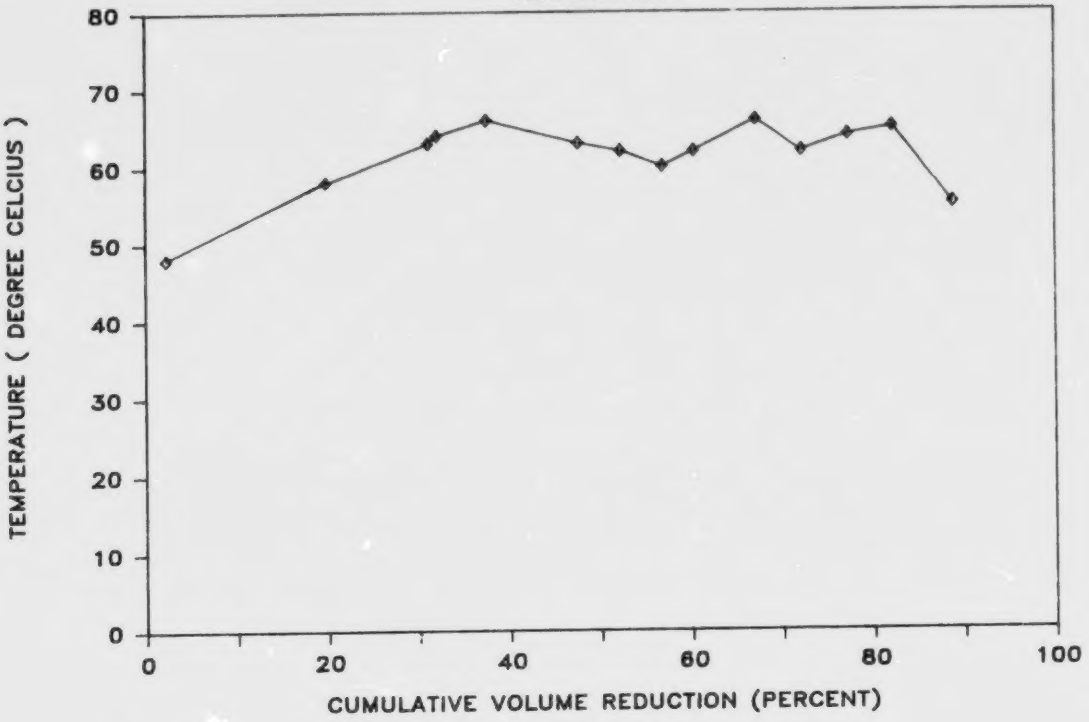
| TIME (MIN) | PERM VOLUME (MLS) | PERM RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | CUM VOL RED (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 78.00 | 1.30 | 35.32 | 1.40 | 1.40 | 2.27 |
| 220.2 | 280.00 | 1.75 | 47.49 | 1.89 | 1.89 | 8.14 |
| 1020.0 | 655.00 | 0.82 | 22.25 | 0.88 | 0.88 | 19.87 |
| 1080.0 | 29.00 | 0.48 | 13.13 | 0.52 | 0.52 | 31.09 |
| 1140.0 | 29.00 | 0.48 | 13.13 | 0.52 | 0.52 | 32.03 |
| 1200.0 | 31.00 | 0.52 | 14.04 | 0.56 | 0.56 | 37.49 |
| 1320.0 | 59.00 | 0.49 | 13.36 | 0.53 | 0.53 | 47.52 |
| 1380.0 | 28.00 | 0.47 | 12.68 | 0.50 | 0.50 | 52.20 |
| 1440.0 | 28.00 | 0.47 | 12.68 | 0.50 | 0.50 | 56.82 |
| 1500.0 | 26.00 | 0.43 | 11.77 | 0.47 | 0.47 | 60.27 |
| 2460.0 | 426.00 | 0.44 | 12.06 | 0.48 | 0.48 | 67.12 |
| 2520.0 | 29.00 | 0.48 | 13.13 | 0.52 | 0.52 | 72.16 |
| 2580.0 | 30.00 | 0.50 | 13.59 | 0.54 | 0.54 | 77.26 |
| 2640.0 | 28.00 | 0.47 | 12.68 | 0.50 | 0.50 | 82.16 |
| 2760.0 | 30.00 | 0.25 | 6.79 | 0.27 | 0.27 | 88.80 |
| 2820.0 | 6.00 | 0.10 | 2.72 | 0.11 | 0.11 | 90.10 |

PS CELL 3
PRESSURE: 140 psi
PRESSURE CORRECTION FACTOR 1.07

| TIME (MIN) | PERM VOLUME (MLS) | PERM RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2·D) | CORR FLUX RATE (M3/M2·D) | CUM VOL RED (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 117.00 | 1.950 | 52.982 | 2.106 | 2.253 | 2.27 |
| 220.2 | 270.00 | 1.685 | 45.792 | 1.820 | 1.948 | 8.14 |
| 1020.0 | 574.00 | 0.718 | 19.499 | 0.775 | 0.829 | 19.87 |
| 1080.0 | 18.00 | 0.300 | 8.151 | 0.324 | 0.347 | 31.09 |
| 1140.0 | 19.00 | 0.317 | 8.604 | 0.342 | 0.366 | 32.03 |
| 1200.0 | 20.00 | 0.333 | 9.057 | 0.360 | 0.385 | 37.49 |
| 1320.0 | 35.00 | 0.292 | 7.925 | 0.315 | 0.337 | 47.52 |
| 1380.0 | 17.00 | 0.283 | 7.698 | 0.306 | 0.327 | 52.20 |
| 1440.0 | 16.00 | 0.267 | 7.245 | 0.288 | 0.308 | 56.82 |
| 1500.0 | 16.00 | 0.267 | 7.245 | 0.288 | 0.308 | 60.27 |
| 2460.0 | 246.00 | 0.256 | 6.962 | 0.277 | 0.296 | 67.12 |
| 2520.0 | 17.00 | 0.283 | 7.698 | 0.306 | 0.327 | 72.16 |
| 2580.0 | 17.00 | 0.283 | 7.698 | 0.306 | 0.327 | 77.26 |
| 2640.0 | 16.00 | 0.267 | 7.245 | 0.288 | 0.308 | 82.16 |
| 2760.0 | 16.00 | 0.133 | 3.623 | 0.144 | 0.154 | 88.80 |
| 2820.0 | 3.00 | 0.050 | 1.359 | 0.054 | 0.058 | 90.10 |

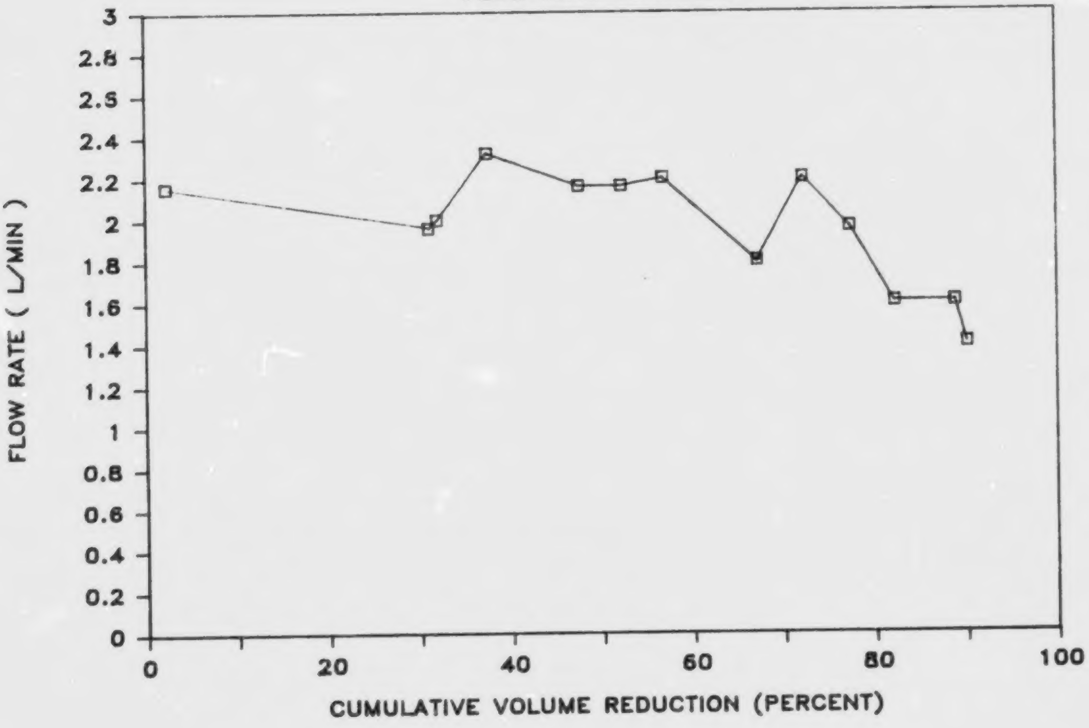
## BATCH CONCENTRATION

TEMPERATURE



## BATCH CONCENTRATION

FLOW RATE TO CELLS



STABILITY EXPERIMENT
% CUMULATIVE VOLUME REDUCTION
OCTOBER 3 17 1984
VOLUME OF FEED

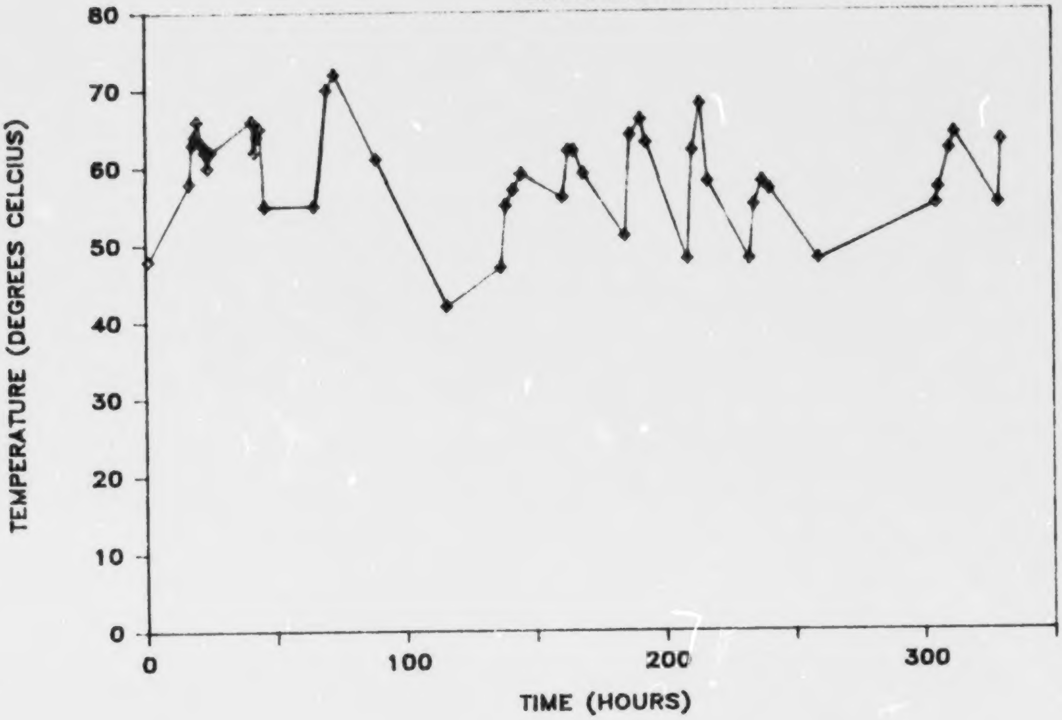
| TIME | CHP | TFC | PS | TFC | PS | CHP | 30 L PVDF LRG CELLS | TOTAL | CUM TOT | VOLUME REDUC. | CUM VOLUME REDUC. | FEED RATE | FEED TEMP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (HRS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | PERM VOL (MLS) | % | % | L/MIN | C |
| 1.00 | 189.00 | 78.00 | 117.00 | 62.00 | 121.00 | 115.00 | | 682.00 | 682.00 | 2.27 | 2.27 | 2.16 | 48 |
| 3.67 | 350.00 | 280.00 | 270.00 | 255.00 | 304.00 | 300.00 | | 1759.00 | 2441.00 | 5.86 | 8.14 | | |
| 17.00 | 750.00 | 655.00 | 574.00 | 527.00 | 569.00 | 444.00 | | 3519.00 | 5960.00 | 11.73 | 19.87 | | 58 |
| 18.00 | 42.00 | 29.00 | 18.00 | 15.00 | 16.00 | 10.00 | 3237.00 | 3367.00 | 9327.00 | 11.22 | 31.09 | 1.96 | 63 |
| 19.00 | 38.00 | 29.00 | 19.00 | 17.00 | 18.00 | 11.00 | 150.00 | 282.00 | 9609.00 | 0.94 | 32.03 | 2.00 | 64 |
| 20.00 | 46.00 | 31.00 | 20.00 | 19.00 | 19.00 | 12.00 | 1490.00 | 1637.00 | 11246.00 | 5.46 | 37.49 | 2.32 | 66 |
| 22.00 | 79.00 | 59.00 | 35.00 | 36.00 | 36.00 | 25.00 | 2741.00 | 3011.00 | 14257.00 | 10.04 | 47.52 | 2.16 | 63 |
| 23.00 | 34.00 | 28.00 | 17.00 | 18.00 | 18.00 | 13.00 | 1275.00 | 1403.00 | 15660.00 | 4.68 | 52.20 | 2.16 | 62 |
| 24.00 | 34.00 | 28.00 | 16.00 | 17.00 | 18.00 | 13.00 | 1260.00 | 1386.00 | 17046.00 | 4.62 | 56.82 | 2.20 | 60 |
| 25.00 | 35.00 | 26.00 | 16.00 | 17.00 | 18.00 | 13.00 | 910.00 | 1035.00 | 18081.00 | 3.45 | 60.27 | | 62 |
| 41.00 | 496.00 | 426.00 | 246.00 | 290.00 | 337.00 | 259.00 | | 2054.00 | 20135.00 | 6.85 | 67.12 | 1.80 | 66 |
| 42.00 | 30.00 | 29.00 | 17.00 | 19.00 | 24.00 | 18.00 | 1375.00 | 1512.00 | 21647.00 | 5.04 | 72.16 | 2.20 | 62 |
| 43.00 | 29.00 | 30.00 | 17.00 | 20.00 | 26.00 | 20.00 | 1390.00 | 1532.00 | 23179.00 | 5.11 | 77.26 | 1.96 | 64 |
| 44.00 | 27.00 | 28.00 | 16.00 | 20.00 | 26.00 | 21.00 | 1330.00 | 1468.00 | 24647.00 | 4.89 | 82.16 | 1.60 | 65 |
| 46.00 | 30.00 | 30.00 | 16.00 | 20.00 | 29.00 | 23.00 | 1845.00 | 1993.00 | 26640.00 | 6.64 | 88.80 | 1.60 | 55 |
| 47.00 | 6.00 | 6.00 | 3.00 | 4.00 | 5.00 | 5.00 | 360.00 | 389.00 | 27029.00 | 1.30 | 90.10 | 1.40 | |
| 49.00 | 6.00 | 5.50 | 3.00 | 3.00 | 5.00 | 3.50 | | | | | 90.10 | 1.20 | |
| 65.00 | 65.50 | 54.50 | 17.50 | 22.00 | 44.00 | 22.00 | | | | | 90.10 | 1.20 | 55 |
| 67.00 | 24.00 | 29.00 | 6.50 | 19.50 | 30.50 | 30.00 | | | | | 90.10 | | |
| 70.00 | 47.50 | 59.00 | 11.50 | 36.00 | 59.00 | 61.50 | | | | | 90.10 | 1.60 | 70 |
| 73.00 | 38.50 | 46.50 | 9.00 | 29.00 | 48.00 | 51.00 | | | | | 90.10 | 1.72 | 72 |
| 88.92 | 142.00 | 162.00 | 30.00 | 107.00 | 185.00 | 202.00 | | | | | 90.10 | 1.80 | 61 |
| 96.48 | 93.00 | 76.00 | 15.00 | 53.00 | 58.00 | 109.00 | | | | | 90.10 | | |
| 115.98 | 124.00 | 159.00 | 30.00 | 114.00 | 203.00 | 242.00 | | | | | 90.10 | | 42 |
| 137.00 | 91.00 | 126.00 | 24.00 | 103.00 | 141.00 | 213.00 | | | | | 90.10 | 2.32 | 47 |

CON'T

| TIME<br>(HRS) | CHP<br>PERM VOL<br>(MLS) | TFC<br>PERM VOL<br>(MLS) | PS<br>PERM VOL<br>(MLS) | TFC<br>PERM VOL<br>(MLS) | PS<br>PERM VOL<br>(MLS) | CHP<br>PERM VOL<br>(MLS) | PVDF LRG CELLS<br>PERM VOL<br>(MLS) | TOTAL<br>PERM VOL<br>(MLS) | CUM TOT<br>PERM VOL<br>(MLS) | VOLUME REDUC.<br>% | CUM VOLUME REDUC.<br>% | FEED RATE<br>L/MIN | FEED TEMP<br>C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 139.00 | 11.50 | 16.00 | 3.00 | 13.00 | 16.00 | 24.50 | | | | | 90.10 | 1.60 | 55 |
| 142.00 | 17.50 | 24.00 | 4.00 | 19.00 | 24.00 | 36.50 | | | | | 90.10 | 2.16 | 57 |
| 145.00 | 17.00 | 23.50 | 4.00 | 19.00 | 24.00 | 37.00 | | | | | 90.10 | 2.04 | 59 |
| 161.00 | 68.50 | 90.50 | 14.00 | 70.00 | 89.00 | 145.00 | | | | | 90.10 | 2.06 | 56 |
| 163.00 | 13.00 | 17.50 | 3.00 | 13.00 | 14.50 | 22.50 | | | | | 90.10 | 1.60 | 62 |
| 163.25 | 3.50 | 4.00 | 0.50 | 2.50 | 2.50 | 2.50 | | | | | 90.10 | 2.64 | |
| 165.00 | 10.50 | 15.00 | 2.50 | 12.00 | 14.00 | 25.00 | | | | | 90.10 | | 62 |
| 169.00 | 19.00 | 28.00 | 4.50 | 23.00 | 27.00 | 52.00 | | | | | 90.10 | 2.12 | 59 |
| 185.00 | 69.50 | 99.50 | 13.00 | 74.50 | 75.50 | 158.00 | | | | | 90.10 | 1.72 | 51 |
| 187.00 | 13.00 | 19.00 | 2.50 | 14.00 | 11.00 | 24.00 | | | | | 90.10 | 1.52 | 64 |
| 191.00 | 24.50 | 38.50 | 4.00 | 26.00 | 19.00 | 50.00 | | | | | 90.10 | 2.08 | 66 |
| 193.00 | 9.00 | 15.00 | 1.00 | 12.00 | 8.00 | 23.50 | | | | | 90.10 | 2.40 | 63 |
| 209.00 | 45.50 | 73.50 | 6.00 | 55.00 | 36.00 | 117.00 | | | | | 90.10 | 2.32 | 48 |
| 211.00 | 8.50 | 15.00 | 1.50 | 11.50 | 7.00 | 20.50 | | | | | 90.10 | 1.80 | 62 |
| 214.00 | 15.00 | 28.00 | 2.50 | 19.50 | 13.00 | 42.00 | | | | | 90.10 | 1.92 | 68 |
| 217.00 | 12.50 | 23.00 | 2.00 | 17.00 | 9.50 | 30.50 | | | | | 90.10 | | 58 |
| 233.00 | 45.50 | 94.00 | 7.00 | 69.50 | 37.50 | 120.00 | | | | | 90.10 | | 48 |
| 235.00 | 6.50 | 13.00 | 1.00 | 10.00 | 5.00 | 15.00 | | | | | 90.10 | | 55 |
| 238.00 | 10.50 | 20.50 | 2.00 | 16.00 | 8.00 | 23.50 | | | | | 90.10 | | 58 |
| 241.00 | 9.50 | 19.00 | 1.00 | 15.00 | 6.50 | 22.00 | | | | | 90.10 | | 57 |
| 259.50 | 37.50 | 86.00 | 4.50 | 50.00 | 23.00 | 76.00 | | | | | 90.10 | | 48 |
| 286.00 | 37.50 | 74.00 | 3.50 | 56.00 | 21.00 | 84.00 | | | | | 90.10 | | |
| 305.00 | 113.00 | 204.00 | 28.00 | 151.00 | 39.50 | 179.00 | | | | | 90.10 | | 55 |
| 306.00 | 3.50 | 7.00 | 0.50 | 6.00 | 1.00 | 8.50 | | | | | 90.10 | | 57 |
| 310.00 | 15.00 | 29.50 | 2.50 | 25.00 | 5.50 | 34.50 | | | | | 90.10 | | 62 |
| 312.00 | 7.50 | 14.50 | 1.00 | 13.00 | 2.50 | 18.00 | | | | | 90.10 | | 64 |
| 329.00 | 43.00 | 86.00 | 3.50 | 65.00 | 14.00 | 103.00 | | | | | 90.10 | | 55 |
| 330.00 | 3.50 | 7.00 | 0.20 | 6.00 | 1.00 | 8.00 | | | | | 90.10 | | 63 |

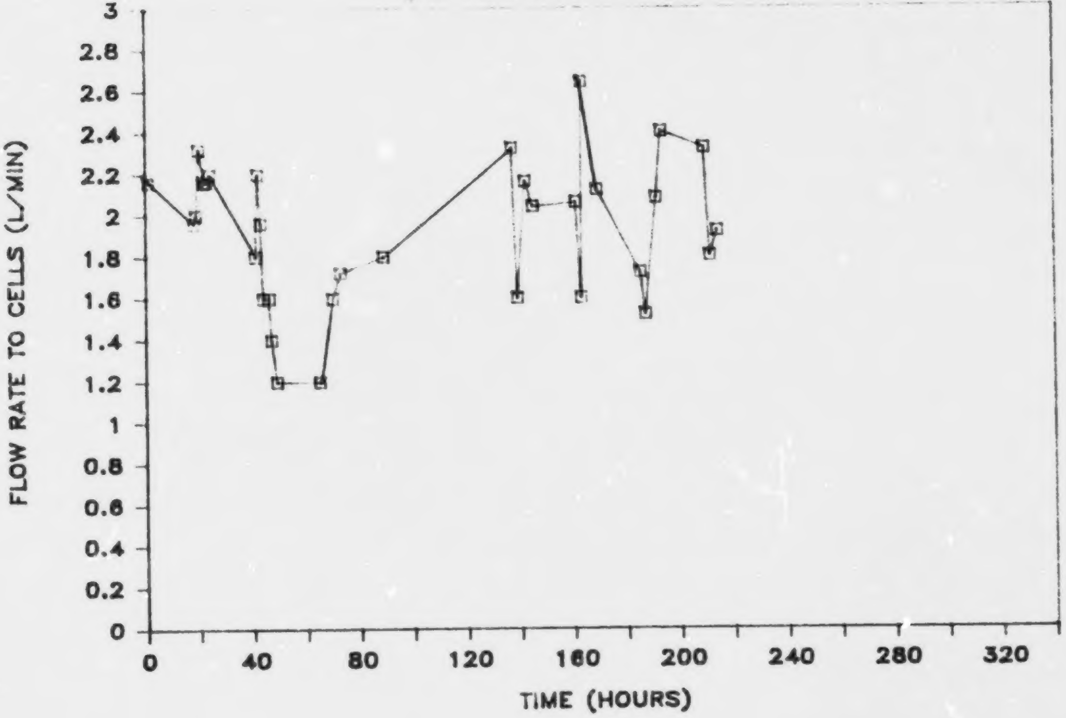
## STABILITY EXPERIMENT

TEMPERATURE



## STABILITY EXPERIMENT

(TEMPERATURE 65C, pH AS IS)



## STABILITY EXPERIMENT

TFC CELL 4
PRESSURE: 130 psi
PRESSURE CORRECTION FACTOR 1.13

| TIME (MIN) | PERM RATE (MLS) | PERM RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2 D) | PRESS CORR (M3/M2 D) | CUM VOL RED (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 62.00 | 1.03 | 28.08 | 1.12 | 1.26 | 2.27 |
| 220.2 | 255.00 | 1.59 | 43.25 | 1.72 | 1.94 | 8.14 |
| 1020.0 | 527.00 | 0.66 | 17.90 | 0.71 | 0.80 | 19.87 |
| 1080.0 | 15.00 | 0.25 | 6.79 | 0.27 | 0.31 | 31.09 |
| 1140.0 | 17.00 | 0.28 | 7.70 | 0.31 | 0.35 | 32.03 |
| 1200.0 | 19.00 | 0.32 | 8.60 | 0.34 | 0.39 | 37.49 |
| 1320.0 | 36.00 | 0.30 | 8.15 | 0.32 | 0.37 | 47.52 |
| 1380.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.37 | 52.20 |
| 1440.0 | 17.00 | 0.28 | 7.70 | 0.31 | 0.35 | 56.82 |
| 1500.0 | 17.00 | 0.28 | 7.70 | 0.31 | 0.35 | 60.27 |
| 2460.0 | 290.00 | 0.30 | 8.21 | 0.33 | 0.37 | 67.12 |
| 2520.0 | 19.00 | 0.32 | 8.60 | 0.34 | 0.39 | 72.16 |
| 2580.0 | 20.00 | 0.33 | 9.06 | 0.36 | 0.41 | 77.26 |
| 2640.0 | 20.00 | 0.33 | 9.06 | 0.36 | 0.41 | 82.16 |
| 2760.0 | 20.00 | 0.17 | 4.53 | 0.18 | 0.20 | 88.80 |
| 2820.0 | 4.00 | 0.07 | 1.81 | 0.07 | 0.08 | 90.10 |
| 2940.0 | 3.00 | 0.03 | 0.68 | 0.03 | 0.03 | 90.10 |
| 3900.0 | 22.00 | 0.02 | 0.62 | 0.02 | 0.03 | 90.10 |
| 4020.0 | 19.50 | 0.16 | 4.42 | 0.18 | 0.20 | 90.10 |
| 4200.0 | 36.00 | 0.20 | 5.43 | 0.22 | 0.24 | 90.10 |
| 4380.0 | 29.00 | 0.16 | 4.38 | 0.17 | 0.20 | 90.10 |
| 5335.2 | 107.00 | 0.11 | 3.04 | 0.12 | 0.14 | 90.10 |
| 5788.8 | 53.00 | 0.12 | 3.17 | 0.13 | 0.14 | 90.10 |
| 6958.8 | 114.00 | 0.10 | 2.65 | 0.11 | 0.12 | 90.10 |
| 8220.0 | 103.00 | 0.08 | 2.22 | 0.09 | 0.10 | 90.10 |
| 8340.0 | 13.00 | 0.11 | 2.94 | 0.12 | 0.13 | 90.10 |
| 8520.0 | 19.00 | 0.11 | 2.87 | 0.11 | 0.13 | 90.10 |
| 8700.0 | 19.00 | 0.11 | 2.87 | 0.11 | 0.13 | 90.10 |
| 9660.0 | 70.00 | 0.07 | 1.98 | 0.08 | 0.09 | 90.10 |
| 9780.0 | 13.00 | 0.11 | 2.94 | 0.12 | 0.13 | 90.10 |
| 9795.0 | 2.50 | 0.17 | 4.53 | 0.18 | 0.20 | 90.10 |
| 9900.0 | 12.00 | 0.11 | 3.11 | 0.12 | 0.14 | 90.10 |
| 10140.0 | 23.00 | 0.10 | 2.60 | 0.10 | 0.12 | 90.10 |
| 11100.0 | 74.50 | 0.08 | 2.11 | 0.08 | 0.09 | 90.10 |
| 11220.0 | 14.00 | 0.12 | 3.17 | 0.13 | 0.14 | 90.10 |
| 11460.0 | 26.00 | 0.11 | 2.94 | 0.12 | 0.13 | 90.10 |
| 11580.0 | 12.00 | 0.10 | 2.72 | 0.11 | 0.12 | 90.10 |
| 12540.0 | 55.00 | 0.06 | 1.56 | 0.06 | 0.07 | 90.10 |
| 12660.0 | 11.50 | 0.10 | 2.60 | 0.10 | 0.12 | 90.10 |
| 12840.0 | 19.50 | 0.11 | 2.94 | 0.12 | 0.13 | 90.10 |
| 13020.0 | 17.00 | 0.09 | 2.57 | 0.10 | 0.12 | 90.10 |
| 13980.0 | 69.50 | 0.07 | 1.97 | 0.08 | 0.09 | 90.10 |
| 14100.0 | 10.00 | 0.08 | 2.26 | 0.09 | 0.10 | 90.10 |
| 14280.0 | 16.00 | 0.09 | 2.42 | 0.10 | 0.11 | 90.10 |
| 14460.0 | 15.00 | 0.08 | 2.26 | 0.09 | 0.10 | 90.10 |
| 15570.0 | 50.00 | 0.05 | 1.22 | 0.05 | 0.05 | 90.10 |
| 17160.0 | 56.00 | 0.04 | 0.96 | 0.04 | 0.04 | 90.10 |
| 18300.0 | 151.00 | 0.13 | 3.60 | 0.14 | 0.16 | 90.10 |
| 18360.0 | 6.00 | 0.10 | 2.72 | 0.11 | 0.12 | 90.10 |
| 18600.0 | 25.00 | 0.10 | 2.83 | 0.11 | 0.13 | 90.10 |
| 18720.0 | 13.00 | 0.11 | 2.94 | 0.12 | 0.13 | 90.10 |
| 19740.0 | 65.00 | 0.06 | 1.73 | 0.07 | 0.08 | 90.10 |
| 19800.0 | 6.00 | 0.10 | 2.72 | 0.11 | 0.12 | 90.10 |

STABILITY EXPERIMENT
PS CELL 5
PRESSURE: 100 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME (MIN) | PERM RATE (MLS) | PERM RATE (MLS/MIN) | FLUX RATE (US GFD) | FLUX RATE (M3/M2 D) | PRESS CORR (M3/M2 D) | CUM VOL RED (%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 121.00 | 2.02 | 54.79 | 2.18 | 2.90 | 2.27 |
| 220.2 | 304.00 | 1.90 | 51.56 | 2.05 | 2.73 | 8.14 |
| 1020.0 | 569.00 | 0.71 | 19.33 | 0.77 | 1.02 | 19.87 |
| 1080.0 | 16.00 | 0.27 | 7.25 | 0.29 | 0.38 | 31.09 |
| 1140.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 | 32.03 |
| 1200.0 | 19.00 | 0.32 | 8.60 | 0.34 | 0.45 | 37.49 |
| 1320.0 | 36.00 | 0.30 | 8.15 | 0.32 | 0.43 | 47.52 |
| 1380.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 | 52.20 |
| 1440.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 | 56.82 |
| 1500.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 | 60.27 |
| 2460.0 | 337.00 | 0.35 | 9.54 | 0.38 | 0.50 | 67.12 |
| 2520.0 | 24.00 | 0.40 | 10.87 | 0.43 | 0.57 | 72.16 |
| 2580.0 | 26.00 | 0.43 | 11.77 | 0.47 | 0.62 | 77.26 |
| 2640.0 | 26.00 | 0.43 | 11.77 | 0.47 | 0.62 | 82.16 |
| 2760.0 | 29.00 | 0.24 | 6.57 | 0.26 | 0.35 | 88.80 |
| 2820.0 | 5.00 | 0.08 | 2.26 | 0.09 | 0.12 | 90.10 |
| 2940.0 | 5.00 | 0.04 | 1.13 | 0.05 | 0.06 | 90.10 |
| 3900.0 | 44.00 | 0.05 | 1.25 | 0.05 | 0.07 | 90.10 |
| 4020.0 | 30.50 | 0.25 | 6.91 | 0.27 | 0.37 | 90.10 |
| 4200.0 | 59.00 | 0.33 | 8.91 | 0.35 | 0.47 | 90.10 |
| 4380.0 | 48.00 | 0.27 | 7.25 | 0.29 | 0.38 | 90.10 |
| 5335.2 | 185.00 | 0.19 | 5.26 | 0.21 | 0.28 | 90.10 |
| 5788.8 | 58.00 | 0.13 | 3.47 | 0.14 | 0.18 | 90.10 |
| 6958.3 | 203.00 | 0.17 | 4.71 | 0.19 | 0.25 | 90.10 |
| 8220.0 | 141.00 | 0.11 | 3.04 | 0.12 | 0.16 | 90.10 |
| 8340.0 | 16.00 | 0.13 | 3.62 | 0.14 | 0.19 | 90.10 |
| 8520.0 | 24.00 | 0.13 | 3.62 | 0.14 | 0.19 | 90.10 |
| 8700.0 | 24.00 | 0.13 | 3.62 | 0.14 | 0.19 | 90.10 |
| 9660.0 | 89.00 | 0.09 | 2.52 | 0.10 | 0.13 | 90.10 |
| 9780.0 | 14.50 | 0.12 | 3.28 | 0.13 | 0.17 | 90.10 |
| 9795.0 | 2.50 | 0.17 | 4.53 | 0.18 | 0.24 | 90.10 |
| 9900.0 | 14.00 | 0.13 | 3.62 | 0.14 | 0.19 | 90.10 |
| 10140.0 | 27.00 | 0.11 | 3.06 | 0.12 | 0.16 | 90.10 |
| 11100.0 | 75.50 | 0.08 | 2.14 | 0.08 | 0.11 | 90.10 |
| 11220.0 | 11.00 | 0.09 | 2.49 | 0.10 | 0.13 | 90.10 |
| 11460.0 | 19.00 | 0.08 | 2.15 | 0.09 | 0.11 | 90.10 |
| 11580.0 | 8.00 | 0.07 | 1.81 | 0.07 | 0.10 | 90.10 |
| 12540.0 | 36.00 | 0.04 | 1.02 | 0.04 | 0.05 | 90.10 |
| 12660.0 | 7.00 | 0.06 | 1.58 | 0.06 | 0.08 | 90.10 |
| 12840.0 | 13.00 | 0.07 | 1.96 | 0.08 | 0.10 | 90.10 |
| 13020.0 | 9.50 | 0.05 | 1.43 | 0.06 | 0.08 | 90.10 |
| 13980.0 | 37.50 | 0.04 | 1.06 | 0.04 | 0.06 | 90.10 |
| 14100.0 | 5.00 | 0.04 | 1.13 | 0.05 | 0.06 | 90.10 |
| 14280.0 | 8.00 | 0.04 | 1.21 | 0.05 | 0.06 | 90.10 |
| 14460.0 | 6.50 | 0.04 | 0.98 | 0.04 | 0.05 | 90.10 |
| 15570.0 | 23.00 | 0.02 | 0.56 | 0.02 | 0.03 | 90.10 |
| 17160.0 | 21.00 | 0.01 | 0.36 | 0.01 | 0.02 | 90.10 |
| 18300.0 | 39.50 | 0.03 | 0.94 | 0.04 | 0.05 | 90.10 |
| 18360.0 | 1.00 | 0.02 | 0.45 | 0.02 | 0.02 | 90.10 |
| 18600.0 | 5.50 | 0.02 | 0.62 | 0.02 | 0.03 | 90.10 |
| 18720.0 | 2.50 | 0.02 | 0.57 | 0.02 | 0.03 | 90.10 |
| 19740.0 | 14.00 | 0.01 | 0.37 | 0.01 | 0.02 | 90.10 |
| 19800.0 | 1.00 | 0.02 | 0.45 | 0.02 | 0.02 | 90.10 |

STABILITY EXPERIMENT
CHP CELL 6
PRESSURE: 100 psi
PRESSURE CORRECTION FACTOR 1.33

| TIME<br>(MIN) | PERM RATE<br>(MLS) | PERM RATE<br>(MLS/MIN) | FLUX RATE<br>(US GFD) | FLUX RATE<br>(M3/M2 D) | PRESS CORR<br>(M3/M2 D) | CUM VOL RED<br>(%) |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| 60.0 | 115.00 | 1.92 | 52.08 | 2.07 | 2.75 | 2.27 |
| 220.2 | 300.00 | 1.87 | 50.88 | 2.02 | 2.69 | 8.14 |
| 1020.0 | 444.00 | 0.56 | 15.08 | 0.60 | 0.80 | 19.87 |
| 1080.0 | 10.00 | 0.17 | 4.53 | 0.18 | 0.24 | 31.09 |
| 1140.0 | 11.00 | 0.18 | 4.98 | 0.20 | 0.26 | 32.03 |
| 1200.0 | 12.00 | 0.20 | 5.43 | 0.22 | 0.29 | 37.49 |
| 1320.0 | 25.00 | 0.21 | 5.66 | 0.23 | 0.30 | 47.52 |
| 1380.0 | 13.00 | 0.22 | 5.89 | 0.23 | 0.31 | 52.20 |
| 1440.0 | 13.00 | 0.22 | 5.89 | 0.23 | 0.31 | 56.82 |
| 1500.0 | 13.00 | 0.22 | 5.89 | 0.23 | 0.31 | 60.27 |
| 2460.0 | 259.00 | 0.27 | 7.33 | 0.29 | 0.39 | 67.12 |
| 2520.0 | 18.00 | 0.30 | 8.15 | 0.32 | 0.43 | 72.16 |
| 2580.0 | 20.00 | 0.33 | 9.06 | 0.36 | 0.48 | 77.26 |
| 2640.0 | 21.00 | 0.35 | 9.51 | 0.38 | 0.50 | 82.16 |
| 2760.0 | 23.00 | 0.19 | 5.21 | 0.21 | 0.28 | 88.80 |
| 2820.0 | 5.00 | 0.08 | 2.26 | 0.09 | 0.12 | 90.10 |
| 2940.0 | 3.50 | 0.03 | 0.79 | 0.03 | 0.04 | 90.10 |
| 3900.0 | 22.00 | 0.02 | 0.62 | 0.02 | 0.03 | 90.10 |
| 4020.0 | 30.00 | 0.25 | 6.79 | 0.27 | 0.36 | 90.10 |
| 4200.0 | 61.50 | 0.34 | 9.28 | 0.37 | 0.49 | 90.10 |
| 4380.0 | 51.00 | 0.28 | 7.70 | 0.31 | 0.41 | 90.10 |
| 5335.2 | 202.00 | 0.21 | 5.75 | 0.23 | 0.30 | 90.10 |
| 5788.8 | 109.00 | 0.24 | 6.53 | 0.26 | 0.35 | 90.10 |
| 6958.8 | 242.00 | 0.21 | 5.62 | 0.22 | 0.30 | 90.10 |
| 8220.0 | 213.00 | 0.17 | 4.59 | 0.18 | 0.24 | 90.10 |
| 8340.0 | 24.50 | 0.20 | 5.55 | 0.22 | 0.29 | 90.10 |
| 8520.0 | 36.50 | 0.20 | 5.51 | 0.22 | 0.29 | 90.10 |
| 8700.0 | 37.00 | 0.21 | 5.58 | 0.22 | 0.30 | 90.10 |
| 9660.0 | 145.00 | 0.15 | 4.10 | 0.16 | 0.22 | 90.10 |
| 9780.0 | 22.50 | 0.19 | 5.09 | 0.20 | 0.27 | 90.10 |
| 9795.0 | 2.50 | 0.17 | 4.53 | 0.18 | 0.24 | 90.10 |
| 9900.0 | 25.00 | 0.24 | 6.47 | 0.26 | 0.34 | 90.10 |
| 10140.0 | 52.00 | 0.22 | 5.89 | 0.23 | 0.31 | 90.10 |
| 11100.0 | 158.00 | 0.16 | 4.47 | 0.18 | 0.24 | 90.10 |
| 11220.0 | 24.00 | 0.20 | 5.43 | 0.22 | 0.29 | 90.10 |
| 11460.0 | 50.00 | 0.21 | 5.66 | 0.23 | 0.30 | 90.10 |
| 11580.0 | 23.50 | 0.20 | 5.32 | 0.21 | 0.28 | 90.10 |
| 12540.0 | 117.00 | 0.12 | 3.31 | 0.13 | 0.18 | 90.10 |
| 12660.0 | 20.50 | 0.17 | 4.64 | 0.18 | 0.25 | 90.10 |
| 12840.0 | 42.00 | 0.23 | 6.34 | 0.25 | 0.34 | 90.10 |
| 13020.0 | 30.50 | 0.17 | 4.60 | 0.18 | 0.24 | 90.10 |
| 13980.0 | 120.00 | 0.13 | 3.40 | 0.14 | 0.18 | 90.10 |
| 14100.0 | 15.00 | 0.13 | 3.40 | 0.14 | 0.18 | 90.10 |
| 14280.0 | 23.50 | 0.13 | 3.55 | 0.14 | 0.19 | 90.10 |
| 14460.0 | 22.00 | 0.12 | 3.32 | 0.13 | 0.18 | 90.10 |
| 15570.0 | 76.00 | 0.07 | 1.86 | 0.07 | 0.10 | 90.10 |
| 17160.0 | 84.00 | 0.05 | 1.44 | 0.06 | 0.08 | 90.10 |
| 18300.0 | 179.00 | 0.16 | 4.27 | 0.17 | 0.23 | 90.10 |
| 18360.0 | 8.50 | 0.14 | 3.85 | 0.15 | 0.20 | 90.10 |
| 18600.0 | 34.50 | 0.14 | 3.91 | 0.16 | 0.21 | 90.10 |
| 18720.0 | 18.00 | 0.15 | 4.08 | 0.16 | 0.22 | 90.10 |
| 19740.0 | 103.00 | 0.10 | 2.74 | 0.11 | 0.15 | 90.10 |
| 19800.0 | 8.00 | 0.13 | 3.62 | 0.14 | 0.19 | 90.10 |

# APPENDIX F

# RESULTS OF REVERSE OSMOSIS TESTS

## EMR INITIAL SALT WATER FLUX TEST FOR REVERSE OSMOSIS MEMBRANE SELECTION TEST

TFC CELL1

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | | | | | | |
| 60.00 | 5000.00 | 710.00 | 23.67 | 1.92 | 78.00 | 98.44 |
| 90.00 | 3500.00 | 720.00 | 24.00 | 1.95 | 80.00 | 97.71 |
| 120.00 | 4000.00 | 460.00 | 15.33 | 1.24 | 57.00 | 98.58 |
| 150.00 | 3500.00 | 375.00 | 12.50 | 1.01 | 44.00 | 98.74 |
| 210.00 | 4000.00 | 750.00 | 12.50 | 1.01 | 41.00 | 98.98 |
| 270.00 | 4000.00 | 780.00 | 13.00 | 1.05 | 43.00 | 98.93 |

CA CELL2

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | | | | | | |
| 60.00 | 5000.00 | 460.00 | 15.33 | 1.24 | 215.00 | 95.70 |
| 90.00 | 3500.00 | 455.00 | 15.17 | 1.23 | 185.00 | 94.71 |
| 120.00 | 4000.00 | 290.00 | 9.67 | 0.78 | 155.00 | 96.13 |
| 150.00 | 3500.00 | 240.00 | 8.00 | 0.65 | 123.00 | 96.49 |
| 210.00 | 4000.00 | 465.00 | 7.75 | 0.63 | 123.00 | 96.93 |
| 270.00 | 4000.00 | 500.00 | 8.33 | 0.68 | 123.00 | 96.93 |

TFC CELL3

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | | | | | | |
| 60.00 | 5000.00 | 595.00 | 19.83 | 1.61 | 193.00 | 96.14 |
| 90.00 | 3500.00 | 580.00 | 19.33 | 1.57 | 205.00 | 94.14 |
| 120.00 | 4000.00 | 375.00 | 12.50 | 1.01 | 152.00 | 96.20 |
| 150.00 | 3500.00 | 305.00 | 10.17 | 0.83 | 115.00 | 96.71 |
| 210.00 | 4000.00 | 605.00 | 10.08 | 0.82 | 106.00 | 97.35 |
| 270.00 | 4000.00 | 640.00 | 10.67 | 0.87 | 113.00 | 97.18 |

CA CELL4

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | | | | | | |
| 60.00 | 5000.00 | 585.00 | 19.50 | 1.58 | 200.00 | 96.00 |
| 90.00 | 3500.00 | 470.00 | 15.67 | 1.27 | 185.00 | 94.71 |
| 120.00 | 4000.00 | 310.00 | 10.33 | 0.84 | 142.00 | 96.45 |
| 150.00 | 3500.00 | 250.00 | 8.33 | 0.68 | 110.00 | 96.86 |
| 210.00 | 4000.00 | 480.00 | 8.00 | 0.65 | 103.00 | 97.43 |
| 270.00 | 4000.00 | 515.00 | 8.58 | 0.70 | 112.00 | 97.20 |

## EMR TREATMENT OF UF PERMEATE BY REVERSE OSMOSIS, MEMBRANE SELECTION TEST

### TFC CELL1

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | |
| 30.00 | 670.00 | 8.18 | 7.36 | 465.00 | 15.50 | 1.26 | 27.00 | 95.97 |
| 60.00 | 670.00 | 8.27 | 7.15 | 405.00 | 13.50 | 1.10 | 10.00 | 98.51 |
| 90.00 | 710.00 | 8.22 | 7.55 | 390.00 | 13.00 | 1.05 | 5.60 | 99.21 |
| 120.00 | 750.00 | 8.25 | 6.85 | 400.00 | 13.33 | 1.08 | 5.40 | 99.28 |
| 150.00 | 790.00 | 8.25 | 6.75 | 340.00 | 11.33 | 0.92 | 5.40 | 99.32 |
| 180.00 | 875.00 | 8.28 | 6.68 | 335.00 | 11.17 | 0.91 | 5.20 | 99.41 |
| 210.00 | 942.00 | 8.23 | 6.75 | 330.00 | 11.00 | 0.89 | 6.80 | 99.28 |
| 240.00 | 960.00 | 8.29 | 6.65 | 295.00 | 9.83 | 0.80 | 8.30 | 99.14 |
| 270.00 | 1040.00 | 8.50 | 6.68 | 305.00 | 10.17 | 0.83 | 9.00 | 99.13 |

### CA CELL2

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | |
| 30.00 | 670.00 | 8.18 | 7.13 | 310.00 | 10.33 | 0.84 | 47.00 | 92.99 |
| 60.00 | 670.00 | 8.27 | 7.26 | 275.00 | 9.17 | 0.74 | 14.50 | 97.84 |
| 90.00 | 710.00 | 8.22 | 7.32 | 260.00 | 8.67 | 0.70 | 11.00 | 98.45 |
| 120.00 | 750.00 | 8.25 | 6.70 | 255.00 | 8.50 | 0.69 | 10.00 | 98.67 |
| 150.00 | 790.00 | 8.25 | 6.30 | 230.00 | 7.67 | 0.62 | 11.90 | 98.49 |
| 180.00 | 875.00 | 8.28 | 6.55 | 220.00 | 7.33 | 0.60 | 10.20 | 98.83 |
| 210.00 | 942.00 | 8.23 | 6.48 | 215.00 | 7.17 | 0.58 | 11.10 | 98.82 |
| 240.00 | 960.00 | 8.29 | 6.45 | 185.00 | 6.17 | 0.50 | 13.20 | 98.63 |
| 270.00 | 1040.00 | 8.50 | 6.51 | 195.00 | 6.50 | 0.53 | 13.60 | 98.69 |

### TFC CELL3

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | |
| 30.00 | 670.00 | 8.18 | 6.95 | 385.00 | 12.83 | 1.04 | 37.00 | 94.48 |
| 60.00 | 670.00 | 8.27 | 7.45 | 325.00 | 10.83 | 0.88 | 11.30 | 98.31 |
| 90.00 | 710.00 | 8.22 | 7.18 | 310.00 | 10.33 | 0.84 | 8.00 | 98.87 |
| 120.00 | 750.00 | 8.25 | 6.65 | 310.00 | 10.33 | 0.84 | 7.10 | 99.05 |
| 150.00 | 790.00 | 8.25 | 6.45 | 255.00 | 8.50 | 0.69 | 8.00 | 98.99 |
| 180.00 | 875.00 | 8.28 | 6.46 | 260.00 | 8.67 | 0.70 | 7.30 | 99.17 |
| 210.00 | 942.00 | 8.23 | 6.50 | 255.00 | 8.50 | 0.69 | 8.40 | 99.11 |
| 240.00 | 960.00 | 8.29 | 6.55 | 210.00 | 7.00 | 0.57 | 8.40 | 99.13 |
| 270.00 | 1040.00 | 8.50 | 6.47 | 225.00 | 7.50 | 0.61 | 10.10 | 99.03 |

### CA CELL4

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 0.00 | | | | | | | | |
| 30.00 | 670.00 | 8.18 | 7.22 | 340.00 | 11.33 | 0.92 | 57.00 | 91.49 |
| 60.00 | 670.00 | 8.27 | 7.60 | 300.00 | 10.00 | 0.81 | 15.00 | 97.76 |
| 90.00 | 710.00 | 8.22 | 7.00 | 280.00 | 9.33 | 0.76 | 11.60 | 98.37 |
| 120.00 | 750.00 | 8.25 | 6.50 | 285.00 | 9.50 | 0.77 | 11.20 | 98.51 |
| 150.00 | 790.00 | 8.25 | 6.33 | 235.00 | 7.83 | 0.64 | 12.00 | 98.48 |
| 180.00 | 875.00 | 8.28 | 6.47 | 235.00 | 7.83 | 0.64 | 12.80 | 98.54 |
| 210.00 | 942.00 | 8.23 | 6.38 | 230.00 | 7.67 | 0.62 | 14.00 | 98.51 |
| 240.00 | 960.00 | 8.29 | 6.43 | 200.00 | 6.67 | 0.54 | 14.60 | 98.48 |
| 270.00 | 1040.00 | 8.50 | 6.41 | 215.00 | 7.17 | 0.58 | 16.50 | 98.41 |

## CUMMULATIVE VOLUME REDUCTION
## FOR THE R.O. MEMBRANE SELECTION TEST

| TIME (MIN) | TFC CELL1 PERM VOL (MLS) | CA CELL2 PERM VOL (MLS) | TFC CELL3 PERM VOL (MLS) | CA CELL4 PERM VOL (MLS) | TOTAL PERM VOL (MLS) | CUMM. VOL RED (%) |
|---|---|---|---|---|---|---|
| 0.00 | | | | | | |
| 30.00 | 465.00 | 310.00 | 385.00 | 340.00 | 1500.00 | 10.71 |
| 60.00 | 405.00 | 275.00 | 325.00 | 300.00 | 2805.00 | 20.04 |
| 90.00 | 390.00 | 260.00 | 310.00 | 280.00 | 4045.00 | 28.89 |
| 120.00 | 400.00 | 255.00 | 310.00 | 285.00 | 5295.00 | 37.82 |
| 150.00 | 340.00 | 230.00 | 255.00 | 235.00 | 6355.00 | 45.39 |
| 180.00 | 335.00 | 220.00 | 260.00 | 235.00 | 7405.00 | 52.89 |
| 210.00 | 330.00 | 215.00 | 255.00 | 230.00 | 8435.00 | 60.25 |
| 240.00 | 295.00 | 185.00 | 210.00 | 200.00 | 9325.00 | 66.61 |
| 270.00 | 305.00 | 195.00 | 225.00 | 215.00 | 10265.00 | 73.32 |

# EMR POST SALT WATER FLUX TEST FOR REVERSE OSMOSIS MEMBRANE SELECTION TEST

## TFC CELL1

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 0.00 | | | | | | |
| 30.00 | 1600.00 | 385.00 | 12.83 | 1.04 | 98.00 | 93.88 |
| 60.00 | 3000.00 | 440.00 | 14.67 | 1.19 | 66.00 | 97.80 |
| 90.00 | 3500.00 | 430.00 | 14.33 | 1.16 | 64.00 | 98.17 |
| 120.00 | 3500.00 | 430.00 | 14.33 | 1.16 | 51.00 | 98.54 |
| 150.00 | 3250.00 | 425.00 | 14.17 | 1.15 | 46.00 | 98.58 |

## CA CELL2

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 0.00 | | | | | | |
| 30.00 | 1600.00 | 250.00 | 8.33 | 0.68 | 118.00 | 92.63 |
| 60.00 | 3000.00 | 270.00 | 9.00 | 0.73 | 150.00 | 95.00 |
| 90.00 | 3500.00 | 260.00 | 8.67 | 0.70 | 150.00 | 95.71 |
| 120.00 | 3500.00 | 250.00 | 8.33 | 0.68 | 145.00 | 95.86 |
| 150.00 | 3250.00 | 250.00 | 8.33 | 0.68 | 95.00 | 97.08 |

## TFC CELL3

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 0.00 | | | | | | |
| 30.00 | 1600.00 | 300.00 | 10.00 | 0.81 | 71.00 | 95.56 |
| 60.00 | 3000.00 | 350.00 | 11.67 | 0.95 | 86.00 | 97.13 |
| 90.00 | 3500.00 | 340.00 | 11.33 | 0.92 | 98.00 | 97.20 |
| 120.00 | 3500.00 | 340.00 | 11.33 | 0.92 | 98.00 | 97.20 |
| 150.00 | 3250.00 | 340.00 | 11.33 | 0.92 | 96.00 | 97.05 |

## CA CELL4

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 0.00 | | | | | | |
| 30.00 | 1600.00 | 305.00 | 10.17 | 0.83 | 400.00 | 75.00 |
| 60.00 | 3000.00 | 285.00 | 9.50 | 0.77 | 223.00 | 92.57 |
| 90.00 | 3500.00 | 275.00 | 9.17 | 0.74 | 198.00 | 94.34 |
| 120.00 | 3500.00 | 265.00 | 8.83 | 0.72 | 193.00 | 94.49 |
| 150.00 | 3250.00 | 260.00 | 8.67 | 0.70 | 180.00 | 94.46 |

## EMR INITIAL SALT WATER FLUX TEST FOR REVERSE OSMOSIS OF UF PERMEATE

### CELL1 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 5000.00 | 285.00 | 19.00 | 1.54 | 102.00 | 97.96 |
| 30.00 | 6700.00 | 370.00 | 24.67 | 2.00 | 90.00 | 98.66 |
| 45.00 | 6800.00 | 455.00 | 30.33 | 2.46 | 98.00 | 98.56 |
| 60.00 | 5800.00 | 430.00 | 28.67 | 2.33 | 80.00 | 98.62 |
| 75.00 | 5500.00 | 295.00 | 19.67 | 1.60 | 68.00 | 98.76 |
| 90.00 | 5200.00 | 275.00 | 18.33 | 1.49 | 60.00 | 98.85 |
| 105.00 | 5200.00 | 265.00 | 17.67 | 1.43 | 62.00 | 98.81 |
| 120.00 | 5200.00 | 260.00 | 17.33 | 1.41 | 57.00 | 98.90 |

### CELL2 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 5000.00 | 255.00 | 17.00 | 1.38 | 190.00 | 96.20 |
| 30.00 | 6700.00 | 350.00 | 23.33 | 1.89 | 190.00 | 97.16 |
| 45.00 | 6800.00 | 440.00 | 29.33 | 2.38 | 235.00 | 96.54 |
| 60.00 | 5800.00 | 385.00 | 25.67 | 2.08 | 205.00 | 96.47 |
| 75.00 | 5500.00 | 255.00 | 17.00 | 1.38 | 155.00 | 97.18 |
| 90.00 | 5200.00 | 240.00 | 16.00 | 1.30 | 138.00 | 97.35 |
| 105.00 | 5200.00 | 230.00 | 15.33 | 1.24 | 130.00 | 97.50 |
| 120.00 | 5200.00 | 225.00 | 15.00 | 1.22 | 123.00 | 97.63 |

### CELL3 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 5000.00 | 230.00 | 15.33 | 1.24 | 165.00 | 96.70 |
| 30.00 | 6700.00 | 300.00 | 20.00 | 1.62 | 158.00 | 97.64 |
| 45.00 | 6800.00 | 355.00 | 23.67 | 1.92 | 170.00 | 97.50 |
| 60.00 | 5800.00 | 330.00 | 22.00 | 1.79 | 148.00 | 97.45 |
| 75.00 | 5500.00 | 220.00 | 14.67 | 1.19 | 113.00 | 97.95 |
| 90.00 | 5200.00 | 205.00 | 13.67 | 1.11 | 100.00 | 98.08 |
| 105.00 | 5200.00 | 195.00 | 13.00 | 1.05 | 94.00 | 98.19 |
| 120.00 | 5200.00 | 195.00 | 13.00 | 1.05 | 91.00 | 98.25 |

### CELL4 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 5000.00 | 250.00 | 16.67 | 1.35 | 205.00 | 95.90 |
| 30.00 | 6700.00 | 320.00 | 21.33 | 1.73 | 200.00 | 97.01 |
| 45.00 | 6800.00 | 430.00 | 28.67 | 2.33 | 205.00 | 96.99 |
| 60.00 | 5800.00 | 380.00 | 25.33 | 2.06 | 190.00 | 96.72 |
| 75.00 | 5500.00 | 260.00 | 17.33 | 1.41 | 148.00 | 97.31 |
| 90.00 | 5200.00 | 230.00 | 15.33 | 1.24 | 130.00 | 97.50 |
| 105.00 | 5200.00 | 220.00 | 14.67 | 1.19 | 122.00 | 97.65 |
| 120.00 | 5200.00 | 220.00 | 14.67 | 1.19 | 114.00 | 97.81 |

## CUMMULATIVE VOLUME REDUCTION
## RO TREATMENT OF UF PERMEATE

| TIME (MIN) | TFC CELL1 PERM VOL (MLS) | TFC CELL2 PERM VOL (MLS) | TFC CELL3 PERM VOL (MLS) | TFC CELL4 PERM VOL (MLS) | TOTAL PERM VOL (MLS) | CUMM. VOL RED (%) |
|---|---|---|---|---|---|---|
| 15 | 250 | 235 | 210 | 235 | 930 | 4.13 |
| 30 | 290 | 270 | 230 | 255 | 1045 | 8.78 |
| 45 | 300 | 265 | 230 | 265 | 1060 | 13.49 |
| 60 | 300 | 280 | 240 | 270 | 1090 | 18.33 |
| 75 | 295 | 270 | 230 | 265 | 1060 | 23.04 |
| 90 | 285 | 260 | 225 | 255 | 1025 | 27.60 |
| 105 | 285 | 260 | 225 | 250 | 1020 | 32.13 |
| 120 | 250 | 225 | 200 | 220 | 895 | 36.11 |
| 135 | 285 | 255 | 220 | 250 | 1010 | 40.60 |
| 150 | 280 | 250 | 220 | 250 | 1000 | 45.04 |
| 165 | 275 | 240 | 210 | 240 | 965 | 49.33 |
| 180 | 280 | 240 | 220 | 230 | 970 | 53.64 |
| 195 | 265 | 225 | 200 | 225 | 915 | 57.71 |
| 210 | 275 | 230 | 210 | 235 | 950 | 61.93 |
| 225 | 295 | 235 | 220 | 245 | 995 | 66.36 |
| 240 | 275 | 210 | 200 | 215 | 900 | 70.36 |
| 255 | 325 | 235 | 225 | 260 | 1045 | 75.00 |
| 270 | 345 | 215 | 210 | 260 | 1030 | 79.58 |
| 285 | 370 | 195 | 190 | 265 | 1020 | 84.11 |
| 300 | 360 | 160 | 150 | 240 | 910 | 88.16 |
| 313 | 280 | 90 | 95 | 170 | 635 | 90.98 |

# EMR TREATMENT BY REVERSE OSMOSIS OF UF PERMEATE

## CELL1 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 15 | 590 | | | 250 | 16.67 | 1.35 | 85.0 | 85.59 |
| 30 | 620 | 7.85 | 6.78 | 290 | 19.33 | 1.57 | 9.8 | 98.42 |
| 45 | 690 | | | 300 | 20.00 | 1.62 | 7.2 | 98.96 |
| 60 | 700 | 7.90 | 6.60 | 300 | 20.00 | 1.62 | 8.4 | 98.80 |
| 75 | 750 | | | 295 | 19.67 | 1.60 | 8.9 | 98.81 |
| 90 | 775 | 7.75 | 6.43 | 285 | 19.00 | 1.54 | 6.5 | 99.16 |
| 105 | 820 | | | 285 | 19.00 | 1.54 | 6.0 | 99.27 |
| 120 | 900 | 7.85 | 7.05 | 250 | 16.67 | 1.35 | 6.2 | 99.31 |
| 135 | 950 | | | 285 | 19.00 | 1.54 | 5.7 | 99.40 |
| 150 | 975 | 8.05 | 6.95 | 280 | 18.67 | 1.51 | 6.5 | 99.33 |
| 165 | 970 | | | 275 | 18.33 | 1.49 | 7.6 | 99.22 |
| 180 | 1100 | 7.95 | 7.01 | 280 | 18.67 | 1.51 | 8.3 | 99.25 |
| 195 | 1210 | | | 265 | 17.67 | 1.43 | 7.4 | 99.39 |
| 210 | 1300 | 8.13 | 6.85 | 275 | 18.33 | 1.49 | 8.4 | 99.35 |
| 225 | 1450 | | | 295 | 19.67 | 1.60 | 8.8 | 99.39 |
| 240 | 1550 | 8.20 | 7.03 | 275 | 18.33 | 1.49 | 9.9 | 99.36 |
| 255 | 1900 | | | 325 | 21.67 | 1.76 | 11.2 | 99.41 |
| 270 | 2250 | 8.48 | 6.97 | 345 | 23.00 | 1.87 | 13.0 | 99.42 |
| 285 | 2750 | | | 370 | 24.67 | 2.00 | 15.0 | 99.45 |
| 300 | 3500 | 8.60 | | 360 | 24.00 | 1.95 | 19.2 | 99.45 |
| 313 | 4400 | | | 280 | 21.54 | 1.75 | 28.0 | 99.36 |

## CELL2 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 15 | 590 | | | 235 | 15.67 | 1.27 | 90.0 | 84.75 |
| 30 | 620 | 7.85 | 6.85 | 270 | 18.00 | 1.46 | 14.8 | 97.61 |
| 45 | 690 | | | 265 | 17.67 | 1.43 | 11.8 | 98.29 |
| 60 | 700 | 7.90 | 6.75 | 280 | 18.67 | 1.51 | 10.0 | 98.57 |
| 75 | 750 | | | 270 | 18.00 | 1.46 | 9.6 | 98.72 |
| 90 | 775 | 7.75 | 6.40 | 260 | 17.33 | 1.41 | 10.4 | 98.66 |
| 105 | 820 | | | 260 | 17.33 | 1.41 | 9.3 | 98.87 |
| 120 | 900 | 7.85 | 7.10 | 225 | 15.00 | 1.22 | 9.6 | 98.93 |
| 135 | 950 | | | 255 | 17.00 | 1.38 | 10.3 | 98.92 |
| 150 | 975 | 8.05 | 7.10 | 250 | 16.67 | 1.35 | 10.2 | 98.95 |
| 165 | 970 | | | 240 | 16.00 | 1.30 | 11.4 | 98.82 |
| 180 | 1100 | 7.95 | 6.98 | 240 | 16.00 | 1.30 | 11.1 | 98.99 |
| 195 | 1210 | | | 225 | 15.00 | 1.22 | 15.5 | 98.72 |
| 210 | 1300 | 8.13 | 6.96 | 230 | 15.33 | 1.24 | 16.0 | 98.77 |
| 225 | 1450 | | | 235 | 15.67 | 1.27 | 16.2 | 98.88 |
| 240 | 1550 | 8.20 | 7.15 | 210 | 14.00 | 1.14 | 16.5 | 98.94 |
| 255 | 1900 | | | 235 | 15.67 | 1.27 | 18.1 | 99.05 |
| 270 | 2250 | 8.48 | 7.08 | 215 | 14.33 | 1.16 | 22.0 | 99.02 |
| 285 | 2750 | | | 195 | 13.00 | 1.05 | 24.0 | 99.13 |
| 300 | 3500 | 8.60 | | 160 | 10.67 | 0.87 | 34.0 | 99.03 |
| 313 | 4400 | | | 90 | 6.92 | 0.56 | 41.5 | 99.06 |

## EMR TREATMENT BY REVERSE OSMOSIS OF UF PERMEATE

### CELL3 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 15 | 590 | | | 210 | 14.00 | 1.14 | 56.0 | 90.51 |
| 30 | 620 | 7.85 | 6.85 | 230 | 15.33 | 1.24 | 9.8 | 98.42 |
| 45 | 690 | | | 230 | 15.33 | 1.24 | 8.8 | 98.72 |
| 60 | 700 | 7.90 | 6.85 | 240 | 16.00 | 1.30 | 9.3 | 98.67 |
| 75 | 750 | | | 230 | 15.33 | 1.24 | 7.1 | 99.05 |
| 90 | 775 | 7.75 | 6.32 | 225 | 15.00 | 1.22 | 7.6 | 99.02 |
| 105 | 820 | | | 225 | 15.00 | 1.22 | 7.7 | 99.06 |
| 120 | 900 | 7.85 | 7.20 | 200 | 13.33 | 1.08 | 7.8 | 99.13 |
| 135 | 950 | | | 220 | 14.67 | 1.19 | 10.0 | 98.95 |
| 150 | 975 | 8.05 | 7.05 | 220 | 14.67 | 1.19 | 8.5 | 99.13 |
| 165 | 970 | | | 210 | 14.00 | 1.14 | 9.1 | 99.06 |
| 180 | 1100 | 7.95 | 7.02 | 220 | 14.67 | 1.19 | 10.0 | 99.09 |
| 195 | 1210 | | | 200 | 13.33 | 1.08 | 10.7 | 99.12 |
| 210 | 1300 | 8.13 | 7.08 | 210 | 14.00 | 1.14 | 12.1 | 99.07 |
| 225 | 1450 | | | 220 | 14.67 | 1.19 | 12.8 | 99.12 |
| 240 | 1550 | 8.20 | 7.16 | 200 | 13.33 | 1.08 | 13.8 | 99.11 |
| 255 | 1900 | | | 225 | 15.00 | 1.22 | 17.3 | 99.09 |
| 270 | 2250 | 8.48 | 7.05 | 210 | 14.00 | 1.14 | 21.5 | 99.04 |
| 285 | 2750 | | | 190 | 12.67 | 1.03 | 26.2 | 99.05 |
| 300 | 3500 | 8.60 | | 150 | 10.00 | 0.81 | 28.5 | 99.19 |
| 313 | 4400 | | | 95 | 7.31 | 0.59 | 43.5 | 99.01 |

### CELL4 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | FEED pH | PERMEATE pH | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|---|---|
| 15 | 590 | | | 235 | 15.67 | 1.27 | 129.0 | 78.14 |
| 30 | 620 | 7.85 | 7.03 | 255 | 17.00 | 1.38 | 14.6 | 97.65 |
| 45 | 690 | | | 265 | 17.67 | 1.43 | 14.2 | 97.94 |
| 60 | 700 | 7.90 | 7.01 | 270 | 18.00 | 1.46 | 17.3 | 97.53 |
| 75 | 750 | | | 265 | 17.67 | 1.43 | 8.8 | 98.83 |
| 90 | 775 | 7.75 | 6.33 | 255 | 17.00 | 1.38 | 8.7 | 98.88 |
| 105 | 820 | | | 250 | 16.67 | 1.35 | 9.8 | 98.80 |
| 120 | 900 | 7.85 | 7.20 | 220 | 14.67 | 1.19 | 9.2 | 98.98 |
| 135 | 950 | | | 250 | 16.67 | 1.35 | 9.9 | 98.96 |
| 150 | 975 | 8.05 | 7.17 | 250 | 16.67 | 1.35 | 9.8 | 98.99 |
| 165 | 970 | | | 240 | 16.00 | 1.30 | 11.0 | 98.87 |
| 180 | 1100 | 7.95 | 7.20 | 230 | 15.33 | 1.24 | 12.2 | 98.89 |
| 195 | 1210 | | | 225 | 15.00 | 1.22 | 12.4 | 98.98 |
| 210 | 1300 | 8.13 | 7.10 | 235 | 15.67 | 1.27 | 15.5 | 98.81 |
| 225 | 1450 | | | 245 | 16.33 | 1.33 | 16.0 | 98.90 |
| 240 | 1550 | 8.20 | 7.23 | 215 | 14.33 | 1.16 | 15.0 | 99.03 |
| 255 | 1900 | | | 260 | 17.33 | 1.41 | 18.0 | 99.05 |
| 270 | 2250 | 8.48 | 7.15 | 260 | 17.33 | 1.41 | 17.0 | 99.24 |
| 285 | 2750 | | | 265 | 17.67 | 1.43 | 23.0 | 99.16 |
| 300 | 3500 | 8.60 | | 240 | 16.00 | 1.30 | 24.8 | 99.29 |
| 313 | 4400 | | | 170 | 13.08 | 1.06 | 38.0 | 99.14 |

## EMR POST SALT WATER FLUX TEST
## FOR REVERSE OSMOSIS OF UF PERMEATE

### CELL1 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 4700.00 | 220.00 | 14.67 | 1.19 | 130.00 | 97.23 |
| 30.00 | 4800.00 | 250.00 | 16.67 | 1.35 | 68.00 | 98.58 |
| 45.00 | 4900.00 | 260.00 | 17.33 | 1.41 | 54.00 | 98.90 |
| 60.00 | 4900.00 | 250.00 | 16.67 | 1.35 | 52.50 | 98.93 |
| 75.00 | 4950.00 | 250.00 | 16.67 | 1.35 | 51.50 | 98.96 |
| 90.00 | 4830.00 | 245.00 | 16.33 | 1.33 | 50.00 | 98.96 |
| 105.00 | 4900.00 | 245.00 | 16.33 | 1.33 | 50.00 | 98.98 |
| 120.00 | 4820.00 | 245.00 | 16.33 | 1.33 | 50.00 | 98.96 |

### CELL2 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 4700.00 | 165.00 | 11.00 | 0.89 | 165.00 | 96.49 |
| 30.00 | 4800.00 | 126.00 | 8.40 | 0.68 | 126.00 | 97.38 |
| 45.00 | 4900.00 | 125.00 | 8.33 | 0.68 | 125.00 | 97.45 |
| 60.00 | 4900.00 | 127.00 | 8.47 | 0.69 | 127.00 | 97.41 |
| 75.00 | 4950.00 | 129.00 | 8.60 | 0.70 | 129.00 | 97.39 |
| 90.00 | 4830.00 | 123.00 | 8.20 | 0.67 | 123.00 | 97.45 |
| 105.00 | 4900.00 | 120.00 | 8.00 | 0.65 | 120.00 | 97.55 |
| 120.00 | 4820.00 | 125.00 | 8.33 | 0.68 | 125.00 | 97.41 |

### CELL3 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 4700.00 | 100.00 | 6.67 | 0.54 | 268.00 | 94.30 |
| 30.00 | 4800.00 | 110.00 | 7.33 | 0.60 | 160.00 | 96.67 |
| 45.00 | 4900.00 | 110.00 | 7.33 | 0.60 | 130.00 | 97.35 |
| 60.00 | 4900.00 | 110.00 | 7.33 | 0.60 | 121.00 | 97.53 |
| 75.00 | 4950.00 | 105.00 | 7.00 | 0.57 | 110.00 | 97.78 |
| 90.00 | 4830.00 | 105.00 | 7.00 | 0.57 | 111.00 | 97.70 |
| 105.00 | 4900.00 | 105.00 | 7.00 | 0.57 | 105.00 | 97.86 |
| 120.00 | 4820.00 | 105.00 | 7.00 | 0.57 | 104.00 | 97.84 |

### CELL4 (TFC)

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 15.00 | 4700.00 | 155.00 | 10.33 | 0.84 | 285.00 | 93.94 |
| 30.00 | 4800.00 | 165.00 | 11.00 | 0.89 | 185.00 | 96.15 |
| 45.00 | 4900.00 | 170.00 | 11.33 | 0.92 | 150.00 | 96.94 |
| 60.00 | 4900.00 | 160.00 | 10.67 | 0.87 | 147.00 | 97.00 |
| 75.00 | 4950.00 | 160.00 | 10.67 | 0.87 | 146.00 | 97.05 |
| 90.00 | 4830.00 | 155.00 | 10.33 | 0.84 | 145.00 | 97.00 |
| 105.00 | 4900.00 | 160.00 | 10.67 | 0.87 | 140.00 | 97.14 |
| 120.00 | 4820.00 | 160.00 | 10.67 | 0.87 | 130.00 | 97.30 |

## EMR INITIAL SALT WATER FLUX TEST FOR REVERSE OSMOSIS TEST ON DEMULSIFIED PRODUCED WATER

### CELL1 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 1560.00 | 360.00 | 12.00 | 0.97 | 53.00 | 96.60 |
| 60.00 | 2000.00 | 365.00 | 12.17 | 0.99 | 44.00 | 97.80 |
| 90.00 | 3000.00 | 360.00 | 12.00 | 0.97 | 40.00 | 98.67 |
| 120.00 | 3100.00 | 360.00 | 12.00 | 0.97 | 38.00 | 98.77 |

### CELL2 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 1560.00 | 370.00 | 12.33 | 1.00 | 61.00 | 96.09 |
| 60.00 | 2000.00 | 360.00 | 12.00 | 0.97 | 52.00 | 97.40 |
| 90.00 | 3000.00 | 360.00 | 12.00 | 0.97 | 49.00 | 98.37 |
| 120.00 | 3100.00 | 355.00 | 11.83 | 0.96 | 46.00 | 98.52 |

### CELL3 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 1560.00 | 360.00 | 12.00 | 0.97 | 47.00 | 96.99 |
| 60.00 | 2000.00 | 360.00 | 12.00 | 0.97 | 39.00 | 98.05 |
| 90.00 | 3000.00 | 345.00 | 11.50 | 0.93 | 36.00 | 98.80 |
| 120.00 | 3100.00 | 345.00 | 11.50 | 0.93 | 33.00 | 98.94 |

### CELL4 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 1560.00 | 355.00 | 11.83 | 0.96 | 49.00 | 96.86 |
| 60.00 | 2000.00 | 355.00 | 11.83 | 0.96 | 40.00 | 98.00 |
| 90.00 | 3000.00 | 345.00 | 11.50 | 0.93 | 39.00 | 98.70 |
| 120.00 | 3100.00 | 340.00 | 11.33 | 0.92 | 34.00 | 98.90 |

## CUMULATIVE VOLUME REDUCTION
## RO TREATMENT OF DEMULSIFIED PRODUCED WATER

| TIME (MIN) | TFC CELL1 PERM VOL (MLS) | TFC CELL2 PERM VOL (MLS) | TFC CELL3 PERM VOL (MLS) | TFC CELL4 PERM VOL (MLS) | TOTAL PERM VOL (MLS) | CUMM. VOL RED (%) |
|---|---|---|---|---|---|---|
| 30 | 285 | 295 | 280 | 285 | 1145 | 5.73 |
| 60 | 305 | 300 | 295 | 290 | 1190 | 11.68 |
| 90 | 300 | 290 | 280 | 285 | 1155 | 17.45 |
| 120 | 295 | 280 | 275 | 280 | 1130 | 23.10 |
| 150 | 295 | 280 | 270 | 270 | 1115 | 28.68 |
| 180 | 290 | 265 | 260 | 265 | 1080 | 34.08 |
| 210 | 290 | 265 | 260 | 260 | 1075 | 39.45 |
| 240 | 285 | 255 | 250 | 255 | 1045 | 44.68 |
| 270 | 295 | 245 | 245 | 250 | 1035 | 49.85 |
| 300 | 280 | 245 | 240 | 245 | 1010 | 54.90 |
| 330 | 290 | 250 | 250 | 245 | 1035 | 60.07 |
| 360 | 310 | 255 | 250 | 255 | 1070 | 65.42 |
| 390 | 310 | 260 | 255 | 255 | 1080 | 70.82 |
| 420 | 310 | 250 | 250 | 275 | 1085 | 76.25 |
| 435 | 160 | 125 | 130 | 135 | 550 | 79.00 |

## EMR TREATMENT OF UF PERMEATE BY REVERSE OSMOSIS ON DEMULSIFIED PRODUCED WATER

CELL3 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30 | 1100 | 280 | 9.33 | 0.76 | 26.5 | 97.59 |
| 60 | 1150 | 295 | 9.83 | 0.80 | 10.4 | 99.10 |
| 90 | 1200 | 280 | 9.33 | 0.76 | 11.8 | 99.02 |
| 120 | 1250 | 275 | 9.17 | 0.74 | 10.1 | 99.19 |
| 150 | 1400 | 270 | 9.00 | 0.73 | 11.6 | 99.17 |
| 180 | 1500 | 260 | 8.67 | 0.70 | 11.1 | 99.26 |
| 210 | 1630 | 260 | 8.67 | 0.70 | 11.9 | 99.27 |
| 240 | 1800 | 250 | 8.33 | 0.68 | 12.9 | 99.28 |
| 270 | 1900 | 245 | 8.17 | 0.66 | 14.0 | 99.26 |
| 300 | 2250 | 240 | 8.00 | 0.65 | 17.5 | 99.22 |
| 330 | 1950 | 250 | 8.33 | 0.68 | 17.5 | 99.10 |
| 360 | 1500 | 250 | 8.33 | 0.68 | 23.0 | 98.47 |
| 390 | 3500 | 255 | 8.50 | 0.69 | 26.0 | 99.26 |
| 420 | 5000 | 250 | 8.33 | 0.68 | 38.0 | 99.24 |
| 435 | 4950 | 130 | 8.67 | 0.70 | 30.0 | 99.39 |

CELL4 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30 | 1100 | 285 | 9.50 | 0.77 | 26.5 | 97.59 |
| 60 | 1150 | 290 | 9.67 | 0.78 | 10.4 | 99.10 |
| 90 | 1200 | 285 | 9.50 | 0.77 | 11.8 | 99.02 |
| 120 | 1250 | 280 | 9.33 | 0.76 | 10.1 | 99.19 |
| 150 | 1400 | 270 | 9.00 | 0.73 | 11.6 | 99.17 |
| 180 | 1500 | 265 | 8.83 | 0.72 | 11.1 | 99.26 |
| 210 | 1630 | 260 | 8.67 | 0.70 | 11.9 | 99.27 |
| 240 | 1800 | 255 | 8.50 | 0.69 | 12.9 | 99.28 |
| 270 | 1900 | 250 | 8.33 | 0.68 | 14.0 | 99.26 |
| 300 | 2250 | 245 | 8.17 | 0.66 | 17.5 | 99.22 |
| 330 | 1950 | 245 | 8.17 | 0.66 | 17.5 | 99.10 |
| 360 | 1500 | 255 | 8.50 | 0.69 | 23.0 | 98.47 |
| 390 | 3500 | 255 | 8.50 | 0.69 | 26.0 | 99.26 |
| 420 | 5000 | 275 | 9.17 | 0.74 | 38.0 | 99.24 |
| 435 | 4950 | 135 | 9.00 | 0.73 | 30.0 | 99.39 |

## EMR TREATMENT OF UF PERMEATE BY REVERSE OSMOSIS ON DEMULSIFIED PRODUCED WATER

CELL1 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30 | 1100 | 285 | 9.50 | 0.77 | 26.5 | 97.59 |
| 60 | 1150 | 305 | 10.17 | 0.83 | 10.4 | 99.10 |
| 90 | 1200 | 300 | 10.00 | 0.81 | 11.8 | 99.02 |
| 120 | 1250 | 295 | 9.83 | 0.80 | 10.1 | 99.19 |
| 150 | 1400 | 295 | 9.83 | 0.80 | 11.6 | 99.17 |
| 180 | 1500 | 290 | 9.67 | 0.78 | 11.1 | 99.26 |
| 210 | 1630 | 290 | 9.67 | 0.78 | 11.9 | 99.27 |
| 240 | 1800 | 285 | 9.50 | 0.77 | 12.9 | 99.28 |
| 270 | 1900 | 295 | 9.83 | 0.80 | 14.0 | 99.26 |
| 300 | 2250 | 280 | 9.33 | 0.76 | 17.5 | 99.22 |
| 330 | 1950 | 290 | 9.67 | 0.78 | 17.5 | 99.10 |
| 360 | 1500 | 310 | 10.33 | 0.84 | 23.0 | 98.47 |
| 390 | 3500 | 310 | 10.33 | 0.84 | 26.0 | 99.26 |
| 420 | 5000 | 310 | 10.33 | 0.84 | 38.0 | 99.24 |
| 435 | 4950 | 160 | 10.67 | 0.87 | 30.0 | 99.39 |

CELL2 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30 | 1100 | 295 | 9.83 | 0.80 | 26.5 | 97.59 |
| 60 | 1150 | 300 | 10.00 | 0.81 | 10.4 | 99.10 |
| 90 | 1200 | 290 | 9.67 | 0.78 | 11.8 | 99.02 |
| 120 | 1250 | 280 | 9.33 | 0.76 | 10.1 | 99.19 |
| 150 | 1400 | 280 | 9.33 | 0.76 | 11.6 | 99.17 |
| 180 | 1500 | 265 | 8.83 | 0.72 | 11.1 | 99.26 |
| 210 | 1630 | 265 | 8.83 | 0.72 | 11.9 | 99.27 |
| 240 | 1800 | 255 | 8.50 | 0.69 | 12.9 | 99.28 |
| 270 | 1900 | 245 | 8.17 | 0.66 | 14.0 | 99.26 |
| 300 | 2250 | 245 | 8.17 | 0.66 | 17.5 | 99.22 |
| 330 | 1950 | 250 | 8.33 | 0.68 | 17.5 | 99.10 |
| 360 | 1500 | 255 | 8.50 | 0.69 | 23.0 | 98.47 |
| 390 | 3500 | 260 | 8.67 | 0.70 | 26.0 | 99.26 |
| 420 | 5000 | 250 | 8.33 | 0.68 | 38.0 | 99.24 |
| 435 | 4950 | 125 | 8.33 | 0.68 | 30.0 | 99.39 |

## EMR POST SALT WATER FLUX TEST FOR REVERSE OSMOSIS TEST ON DEMULSIFIED PRODUCED WATER

### CELL1 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 2900.00 | 405.00 | 13.50 | 1.10 | 69.00 | 97.62 |
| 60.00 | 2760.00 | 405.00 | 13.50 | 1.10 | 52.00 | 98.12 |
| 90.00 | 3280.00 | 450.00 | 15.00 | 1.22 | 53.00 | 98.38 |
| 120.00 | 2820.00 | 445.00 | 14.83 | 1.20 | 60.00 | 97.87 |

### CELL2 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 2900.00 | 380.00 | 12.67 | 1.03 | 69.00 | 97.62 |
| 60.00 | 2760.00 | 375.00 | 12.50 | 1.01 | 65.00 | 97.64 |
| 90.00 | 3280.00 | 410.00 | 13.67 | 1.11 | 68.00 | 97.93 |
| 120.00 | 2820.00 | 405.00 | 13.50 | 1.10 | 70.20 | 97.51 |

### CELL3 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 2900.00 | 360.00 | 12.00 | 0.97 | 42.10 | 98.55 |
| 60.00 | 2760.00 | 355.00 | 11.83 | 0.96 | 42.40 | 98.46 |
| 90.00 | 3280.00 | 385.00 | 12.83 | 1.04 | 41.50 | 98.73 |
| 120.00 | 2820.00 | 390.00 | 13.00 | 1.05 | 49.90 | 98.23 |

### CELL4 TFC

| TIME (MIN) | FEED COND. (umHmos) | PERMEATE RATE (MLS) | PERMEATE RATE (MLS/MIN) | FLUX RATE (M3/M2 D) | PERMEATE COND. (umHmos) | PERCENT REJECTION (%) |
|---|---|---|---|---|---|---|
| 30.00 | 2900.00 | 375.00 | 12.50 | 1.01 | 72.50 | 97.50 |
| 60.00 | 2760.00 | 375.00 | 12.50 | 1.01 | 50.10 | 98.18 |
| 90.00 | 3280.00 | 400.00 | 13.33 | 1.08 | 49.00 | 98.51 |
| 120.00 | 2820.00 | 410.00 | 13.67 | 1.11 | 52.00 | 98.16 |

# APPENDIX G

# COSTS OF COMPONENTS OF PRODUCED WATER CLEANING PROCESSES

## G.1 Pretreatment for Ultrafiltration Units

### G.1.1 Design Parameters

Skim tank with surface oil removal, periodic sludge take off and gas blanket.

Flowrate = 540 US.GPM

Nominal Retention Time = 2 hours

### G.1.2 Equipment List and Purchase Costs

| | |
|---|---|
| Skim tank 64,800 US.GAL. | $176,500 |
| Purchase cost of equipment | $176,500 |

## G.1.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 176,500 | |
| Shipping charges | | 17,650 | |
| Installation of equipment | | 14,120 | |
| Foundations | | 35,300 | |
| Instruments | | 8,825 | |
| Piping | | 35,300 | |
| Insulation | | 35,300 | |
| Electrical | | 8,825 | |
| Buildings & structures | | 5,295 | |
| Services | | 14,120 | |
| Misc. | | 8,825 | |
| Taxes | Federal | 36,006 | |
| TOTAL DIRECT COSTS | | | 396,066 |
| Construction and field expenses | | 39,607 | |
| Engineering expenses | | 29,705 | |
| Contractors fees | | 23,269 | |
| Contingencies | | 46,538 | |
| TOTAL INDIRECT COSTS | | | $ 139,118 |
| TOTAL COSTS | | | $ 535,184 |

### G.1.4 Operating and Maintenance Costs

| | |
|---|---|
| Miscellaneous | $1,000/year |
| Contingencies | $1,000/year |
| Total operating and maintenance costs | $2,000/year |

## G.2 **Spiral UF System 1**

(not followed by RO)

### G.2.1 Design Parameters

Feed flowrate = 625,000 US.GPD = 434 GPM

Permeate flowrate = 500,000 US.GPD = 347 GPM

Concentrate flowrate = 125,000 US.GPD = 87 GPM

Percent recovery = 80%

Operating temp. = 65°C

Operating pressure = 100 psi

Membrane type = 8" spiral

Membrane surface area = 300 $ft^2$/membrane

Assumed flux rate = $0.7 \times 0.55\ M^3/M^2 \cdot D$

$= 0.385\ M^3/M^2 D$

$= 9.45\ USG/F^2 \cdot D$

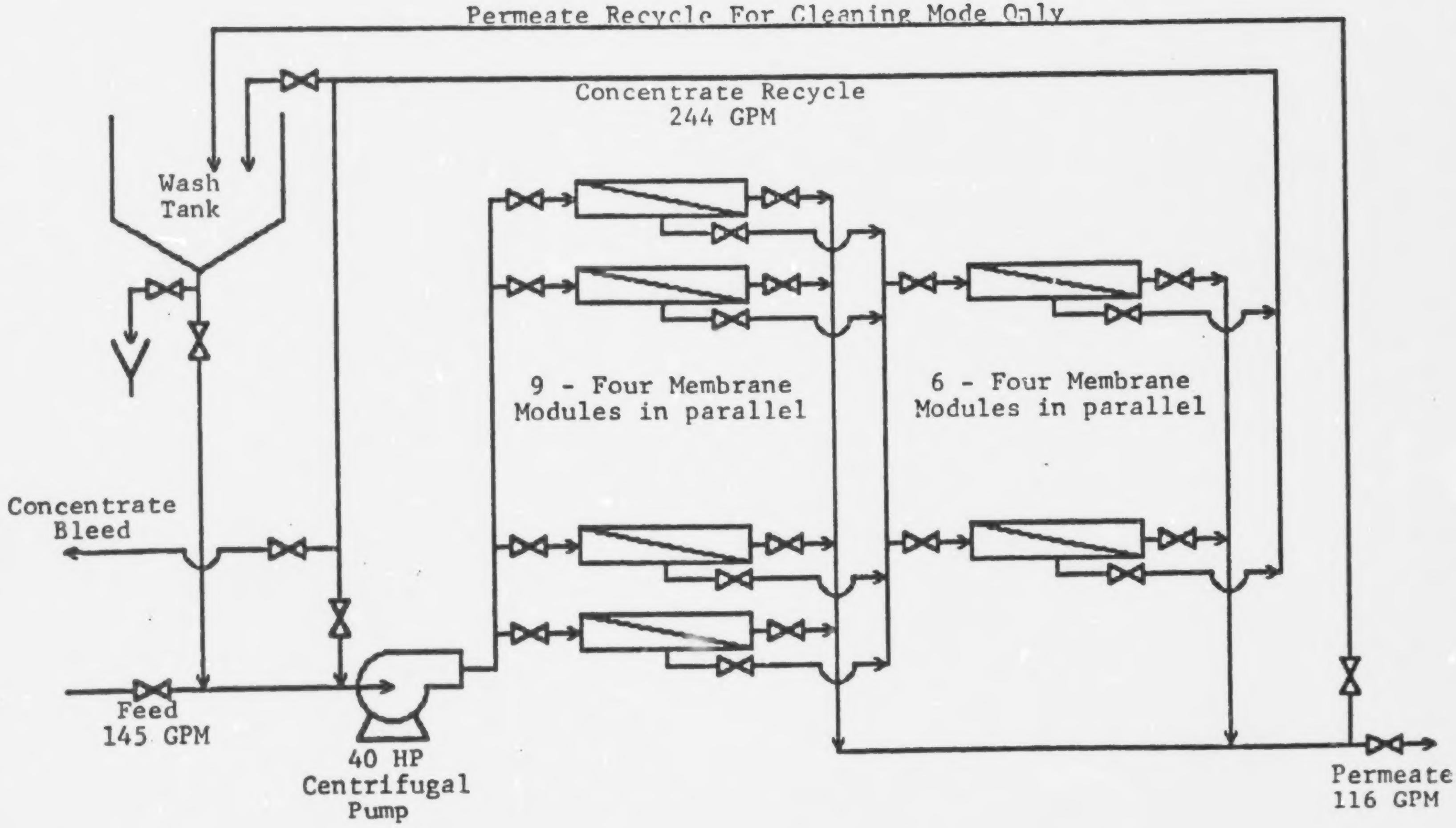
Number of membranes required = 180

Three units each with 15 - 4 membrane modules are required.

### G.2.2 Equipment List and Purchase Cost

| | |
|---|---|
| Purchase cost of each of three, 60 membrane, systems (engineering and assembly work completed) | $291,319 |
| Purchase cost of equipment | $873,957 |

FIGURE G-1 SPIRAL ULTRAFILTRATION FOR PROCESS FOLLOWED BY SODIUM ZEOLITE SOFTENING. (One of three units required.)


Permeate Recycle For Cleaning Mode Only
Concentrate Recycle
244 GPM
Wash
Tank
9 - Four Membrane
Modules in parallel
6 - Four Membrane
Modules in parallel
Concentrate
Bleed
Feed
145 GPM
40 HP
Centrifugal
Pump
Permeate
116 GPM

## G.2.3 Total Cost of Installed Equipment

| | | |
|---|---|---|
| Purchased cost of equipment | $ 873,957 | |
| Shipping charges | 43,698 | |
| Installation of equipment | 53,437 | |
| Foundations | 43,698 | |
| Instruments | 52,437 | |
| Piping | 43,698 | |
| Insulation | 87,396 | |
| Electrical | 69,917 | |
| Buildings & Structures | 87,396 | |
| Services | 69,917 | |
| Misc. | 43,698 | |
| Taxes Federal | | 146,825 |
| TOTAL DIRECT COSTS | $1,615,073 | |
| Construction and field expenses | 80,754 | |
| Engineering expenses | 96,904 | |
| Contractors fees | 89,637 | |
| Contingencies | 179,273 | |
| TOTAL INDIRECT COSTS | | $ 446,568 |
| TOTAL COSTS | | $2,061,640 |

### G.2.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning chemicals (wash every 3 days) | $51,330/year |
| Replacement membranes (every 3 years) | $98,658/year |
| Labour (shared with other parts of plant) (1/2 shift/day at $135/day) | $16,875/year |
| Energy | |
| Electrical Power (120 HP x 0.7457 = 89.5 KW x 24 x 365 x 1.35 cents/KW) | $10,580/year |
| Miscellaneous | $5,000/year |
| Contingency | $18,000/year |
| Total Operating Costs | $200,443/year |

## G.3 **Tubular UF System 1**

(not followed by RO)

### G.3.1 Design Parameters

Feed rate = 625,000 US.GPD = 434 GPM

Permeate flowrate = 500,000 US.GPD = 347 GPM

Concentrate flowrate = 125,000 US.GPD = 87 GPM

Percent recovery = 80%

Operating temperature = 65°C

Operating pressure = 100 psi

Membrane type = 1/2 inch tubular Nito P18 modules

Membrane surface area = 19.4 $ft^2$/module

Assumed flux rate = 0.55 $M^3/M^2 \cdot D$ = 13.5 $USG/F^2 \cdot D$

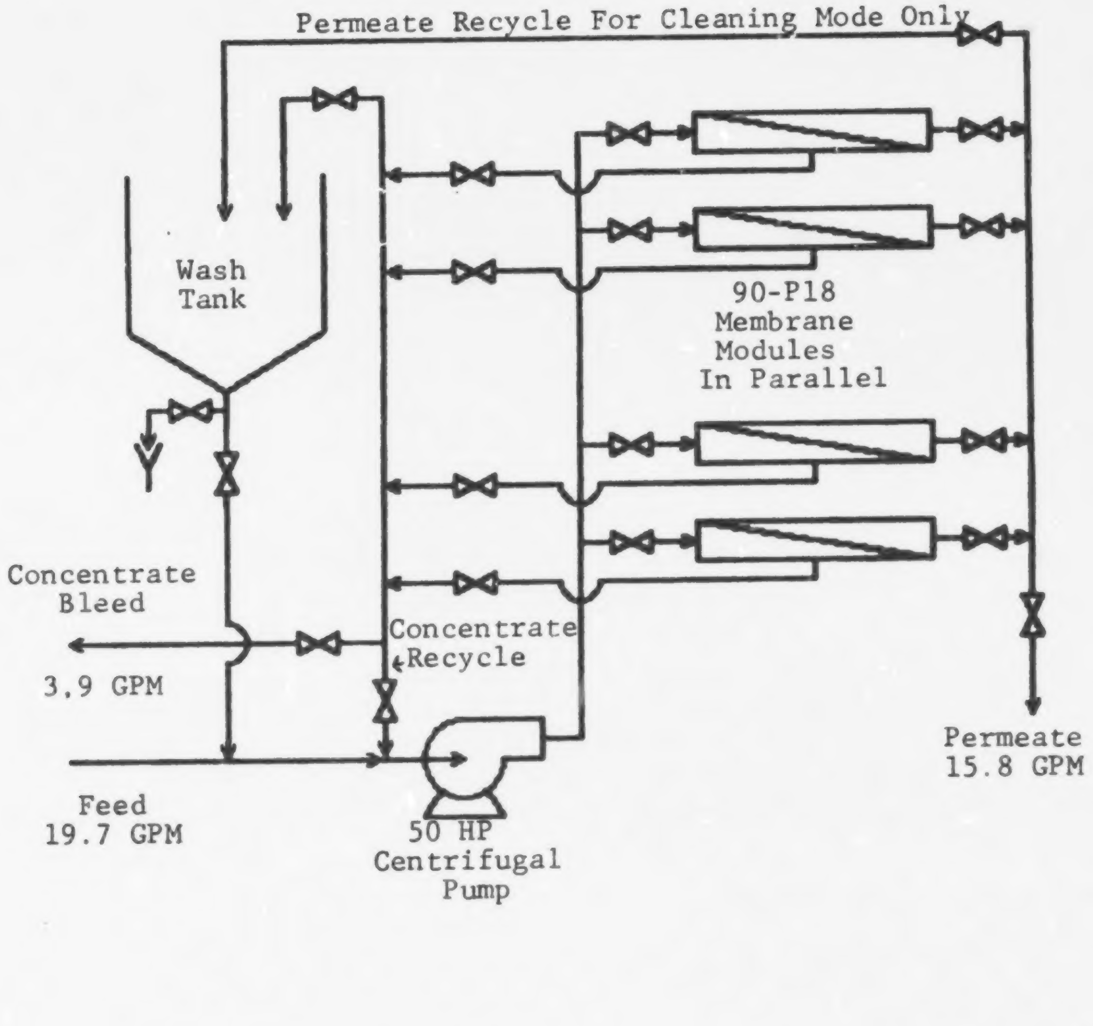
Number of modules required = 1909

22 units each with 90 modules are required.

### G.3.2 Equipment List and Costs

| | |
|---|---|
| Purchase cost of each of 22 membrane systems<br>(engineering and assembly work completed) | 173,340 |
| Purchase cost of equipment | $3,813,480 |

FIGURE G-2 TUBULAR ULTRAFILTRATION SYSTEM FOR PROCESS FOLLOWED BY SODIUM ZEOLITE SOFTENING.
(One of 22 units required)


Permeate Recycle For Cleaning Mode Only
Wash Tank
90-P18 Membrane Modules In Parallel
Concentrate Bleed
3.9 GPM
Concentrate Recycle
Permeate 15.8 GPM
Feed 19.7 GPM
50 HP Centrifugal Pump

### G.3.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 3,813,480 | |
| Shipping charges | | 190,674 | |
| Installation of equipment | | 190,674 | |
| Foundations | | 190,674 | |
| Instruments | | 190,674 | |
| Piping | | 190,674 | |
| Insulation | | 381,348 | |
| Electrical | | 305,078 | |
| Buildings & structures | | 381,348 | |
| Serivces | | 305,078 | |
| Misc. | | 190,674 | |
| Taxes | Federal | 633,038 | |
| TOTAL DIRECT COSTS | | | $6,963,414 |
| Construction and field expenses | | 348,171 | |
| Engineering expenses | | 417,805 | |
| Contractors fees | | 386,470 | |
| Contingencies | | 772,939 | |
| TOTAL INDIRECT COSTS | | | $1,925,384 |
| TOTAL COSTS | | | $8,888,799 |

### G.3.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning chemicals (wash every 4 days) | $225,844/year |
| Replacement membranes (every 3 years) | $297,000/year |
| Labour (shared with other parts of plant) | $33,750/year |
| (1 shift/day at $135/day) | |
| Energy | |
| Electrical Power | $97,000/year |
| (110 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | |
| Miscellaneous | $6,000/year |
| Contingency | $33,000/year |
| Total Operating Costs | $692,594/year |

## G.4 **Post UF Softening**

### G.4.1 Design Parameters

Flow rate = 350 US.GPM

Feed hardness = 2.5 ppm

Silica concentration = 65 ppm

Total dissolved solids = 1600 ppm

Effluent hardness = 0.5 ppm

System consists of two 5.5 foot diameter sodium zeolite softeners

### G.4.2 Equipment List and Purchase Costs

2 - 5.5 foot diameter sodium zeolite softener units = $60,000

Purchase cost of equipment = $60,000

### G.4.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 60,000 | |
| Shipping charges | | 6,000 | |
| Installation of equipment | | 9,000 | |
| Foundations | | 6,000 | |
| Instruments | | 6,000 | |
| Piping | | 18,000 | |
| Insulation | | 12,000 | |
| Electrical | | 4,800 | |
| Buildings & structures | | 6,000 | |
| Serivces | | 7,200 | |
| Misc. | | 3,000 | |
| Taxes | Federal | 13,800 | |
| TOTAL DIRECT COSTS | | | 151,800 |
| Construction and field expenses | | 15,180 | |
| Engineering expenses | | 11,385 | |
| Contractors fees | | 8,918 | |
| Contingencies | | 17,837 | |
| TOTAL INDIRECT COSTS | | | 53,320 |
| TOTAL COSTS | | | $205,120 |

### G.4.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Salt for regeneration | $4,300/year |
| Labour (shared with other parts of plant) | $16,875/year |
| (1/2 shift/day at $135/day) | |
| Miscellaneous | $2,000/year |
| Contingency | $2,300/year |
| Total operating costs | $25,475/year |

## G.5 Post Treatment Storage and $O_2$ Removal

### G.5.1 Design Parameters

Storage tank with a gas blanket and addition of sodium sulfite as an oxygen scavenger.

Flowrate = 350 US.GPM

Storage tank volume = 500,000 US.GAL

Oxygen scavenger concentration added = 50 ppm

### G.5.2 Equipment List and Purchase Costs

| | |
|---|---|
| Storage tank (500,000 US.GAL) | $71,000 |
| Oxygen scavenger addition equipment | $5,000 |
| Purchase cost of equipment | $76,000 |

### G.5.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 76,000 | |
| Shipping charges | | 7,600 | |
| Installation of equipment | | 11,400 | |
| Foundations | | 15,200 | |
| Instruments | | 6,080 | |
| Piping | | 15,200 | |
| Insulation | | 15,200 | |
| Electrical | | 5,320 | |
| Buildings & structures | | 6,080 | |
| Serivces | | 6,080 | |
| Misc. | | 3,800 | |
| Taxes | Federal | 16,796 | |
| TOTAL DIRECT COSTS | | | $184,756 |
| Construction and field expenses | | 18,476 | |
| Engineering expenses | | 13,857 | |
| Contractors fees | | 10,854 | |
| Contingencies | | 21,709 | |
| TOTAL INDIRECT COSTS | | | $ 64,896 |
| TOTAL COSTS | | | $249,652 |

### G.5.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Sodium sulfite (Corrogen) | |
| 50 ppm @ $1.80/Kg | $62,000/year |
| Labour (1/2 shift/day at $135/day) | $16,875/year |
| Miscellaneous | $ 7,400/year |
| Contingencies | $ 8,000/year |
| Total operating and maintenance cost | $94,275/year |

## G.6 Spiral UF System 2

(followed by RO)

### G.6.1 Design Parameters

Feed flowrate = 781,250 US.GPD = 542.5 US.GPM

Permeate flowrate = 625,000 US.GPD = 434 US.GPM

Concentrate flowrate = 156,250 US.GPD = 108.5 US.GPM

Percent recovery = 80%

Operating temperature = 65°C

Operating pressure = 100 psi

Membrane type = 8" spiral

Membrane surface area = 300 $ft^2$/membrane

Assumed flux rate = $0.7 \times 0.55$ $M^3/M^2 \cdot D$

= 0.385 $M^3/M^2 \cdot D$

= 9.45 $USG/F^2 \cdot D$

Number of membranes required = 224

Number of membranes per module = 4

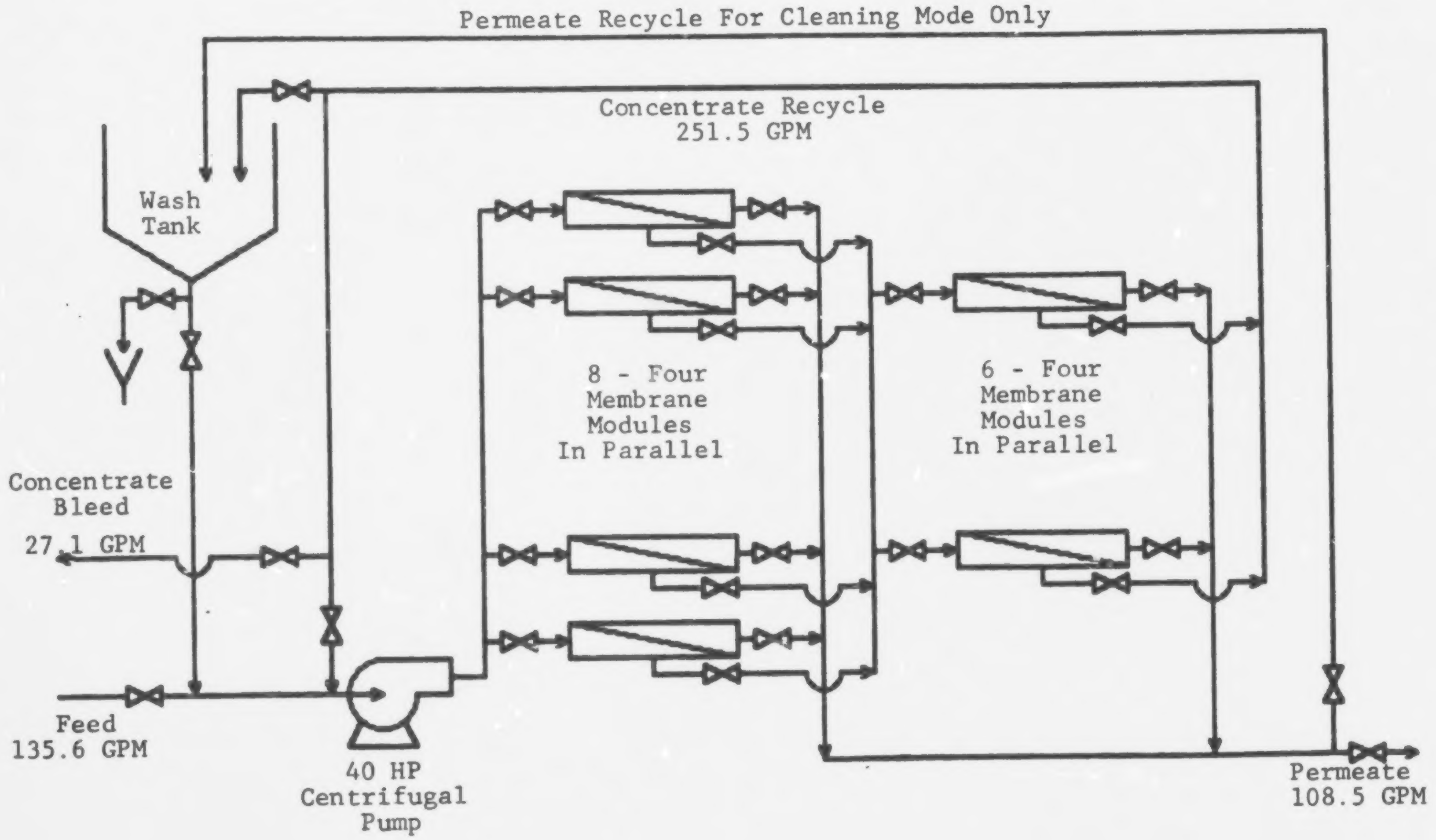
Number of modules = 56

Four units each with 14 - 4 membrane modules are required.

### G.6.2 Equipment List and Purchase Costs

| | |
|---|---|
| Purchase cost of each of four, 60 membrane, systems (engineering and assembly work completed) | $276,921 |
| Purchase cost of equipment | $1,107,684 |

FIGURE G-3 SPIRAL ULTRAFILTRATION SYSTEM FOR PROCESS FOLLOWED BY REVERSE OSMOSIS. (One of four units required)


Permeate Recycle For Cleaning Mode Only
Concentrate Recycle
251.5 GPM
Wash
Tank
8 - Four
Membrane
Modules
In Parallel
6 - Four
Membrane
Modules
In Parallel
Concentrate
Bleed
27.1 GPM
Feed
135.6 GPM
40 HP
Centrifugal
Pump
Permeate
108.5 GPM

## G.6.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 1,107,684 | |
| Shipping charges | | 55,384 | |
| Installation of equipment | | 66,461 | |
| Foundations | | 55,384 | |
| Instruments | | 66,461 | |
| Piping | | 55,384 | |
| Insulation | | 110,768 | |
| Electrical | | 88,615 | |
| Buildings & structures | | 110,768 | |
| Serivces | | 88,615 | |
| Misc. | | 55,384 | |
| Taxes | Federal | 186,091 | |
| TOTAL DIRECT COSTS | | | $2,047,000 |
| Construction and field expenses | | 102,350 | |
| Engineering expenses | | 122,820 | |
| Contractors fees | | 113,609 | |
| Contingencies | | 227,217 | |
| TOTAL INDIRECT COSTS | | | $ 565,996 |
| TOTAL COSTS | | | $2,612,996 |

### G.6.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning Chemicals (wash every 3 days) | $68,440/year |
| Replacement Membranes (every 3 years) | $122,773/year |
| Labour (Shared with other parts of plant) | $16,875/year |
| (1/2 shift/day at $135/day) | $16,875/year |
| Energy | |
| Electrical Power | $14,110/year |
| (160 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | |
| Miscellaneous | $4,000/year |
| Contingency | $22,500/year |
| Total Operating Costs | $248,698/year |

## G.7 **Tubular UF System**

(followed by RO)

### G.7.1 Design Parameters

Feed flowrate = 781,250 US.GPD = 542.5 US.GPM

Permeate flowrate = 625,000 US.GPD = 434 US.GPM

Concentrate flowrate = 156,250 US.GPD = 108.5 US.GPM

Percent recovery = 80%

Operating temperature = 65°C

Operating pressure = 100 psi

Membrane type = 1/2" tubular Nito P18 modules

Membrane surface area = 19.4 $ft^2$/module

Assumed flux rate = 0.55 $M^3/M^2 \cdot D$

= 13.5 $USG/F^2 \cdot D$

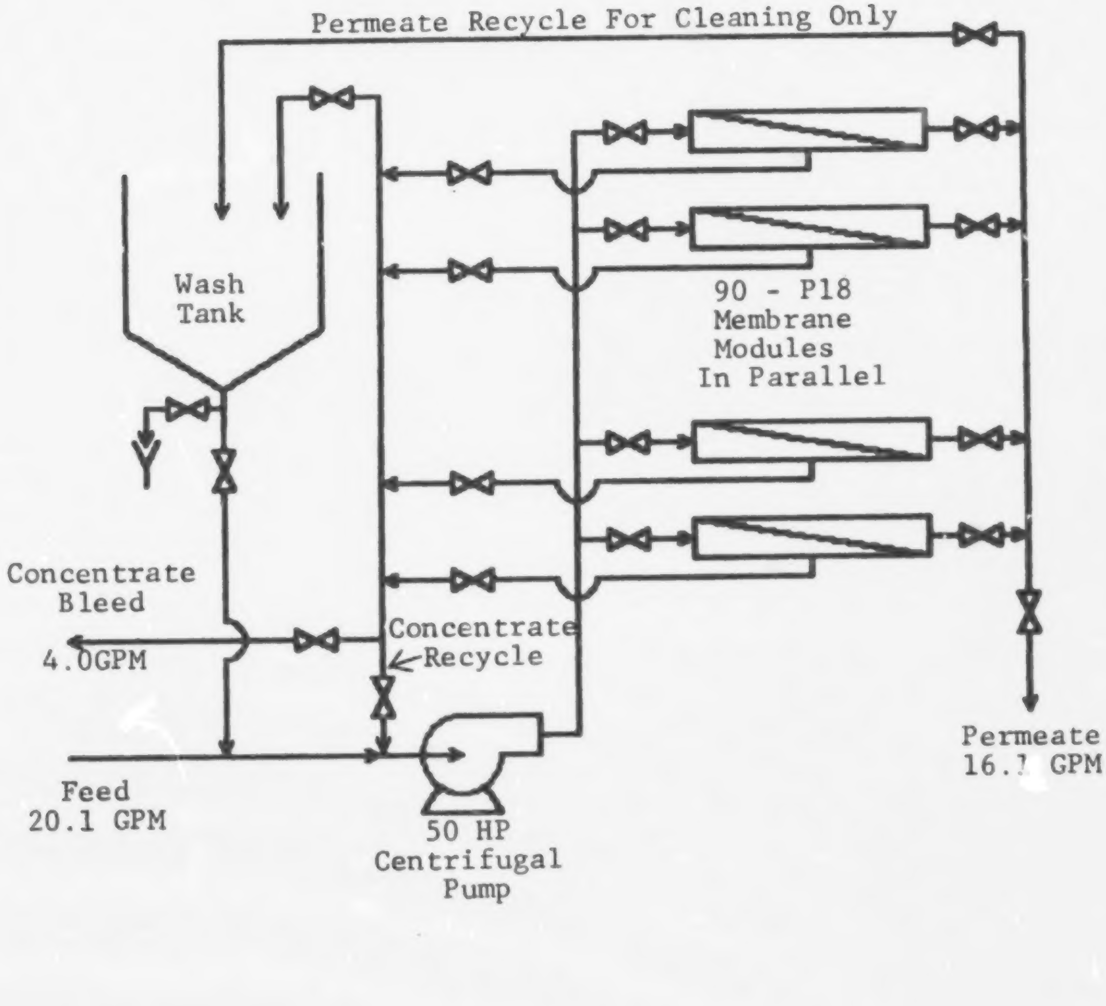
Number of membranes required = 2386

27 units, each with 90 modules, are required.

### G.7.2 Equipment List and Purchase Costs

| | |
|---|---|
| Purchase cost of each of 27 membrane systems (engineering and assembly work completed) | $173,340 |
| Purchase cost of equipment | $4,680,180 |

FIGURE G-4 TUBULAR ULTRAFILTRATION SYSTEM FOR PROCESS FOLLOWED BY REVERSE OSMOSIS.
(One of 27 units required)


Permeate Recycle For Cleaning Only
Wash
Tank
90 - P18
Membrane
Modules
In Parallel
Concentrate
Bleed
4.0GPM
Concentrate
Recycle
Feed
20.1 GPM
50 HP
Centrifugal
Pump
Permeate
16.1 GPM

## G.7.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 4,680,180 | |
| Shipping charges | | 234,009 | |
| Installation of equipment | | 280,811 | |
| Foundations | | 234,009 | |
| Instruments | | 280,811 | |
| Piping | | 234,009 | |
| Insulation | | 468,018 | |
| Electrical | | 374,414 | |
| Buildings & structures | | 468,018 | |
| Serivces | | 374,414 | |
| Misc. | | 234,009 | |
| Taxes | Federal | $786,270 | |
| TOTAL DIRECT COSTS | | | $8,648,973 |
| Construction and field expenses | | 432,449 | |
| Engineering expenses | | 518,938 | |
| Contractors fees | | 480,018 | |
| Contingencies | | 960,036 | |
| TOTAL INDIRECT COSTS | | | $2,391,441 |
| TOTAL COSTS | | | $11,040,414 |

### G.7.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning Chemicals (wash every 3 days) | $277,172/year |
| Replacement Membranes (every 3 years) | $364,500/year |
| Labour (shared with other parts of plant) | |
| (shift/day at $135/day) | $33,750/year |
| Energy | |
| Electrical Power | $119,050/year |
| (1350 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | |
| Miscellaneous | $6,000/year |
| Contingency | $80,000/year |
| Total Operating Costs | $880,472/year |

## G.8 Spiral RO System for UF Permeate

### G.8.1 Design Parameters

Feed flowrate = 625,000 US.GPD = 434 US.GPM

Permeate flowrate = 500,000US.GPD = 347 US.GPM

Concentrate flowrate = 125,000 US.GPD = 87 US.GPM

Percent recovery = 80%

Operating temperature = 35°C

Operating pressure = 600 psi

Membrane type = 8" diameter x 40" spiral TFC Seawater

Membrane surface area = 350 $ft^2$/module

Assumed flux rate = $1.0 M^3/M^2 \cdot D$

= $24.6\ USG/F^2 \cdot D$

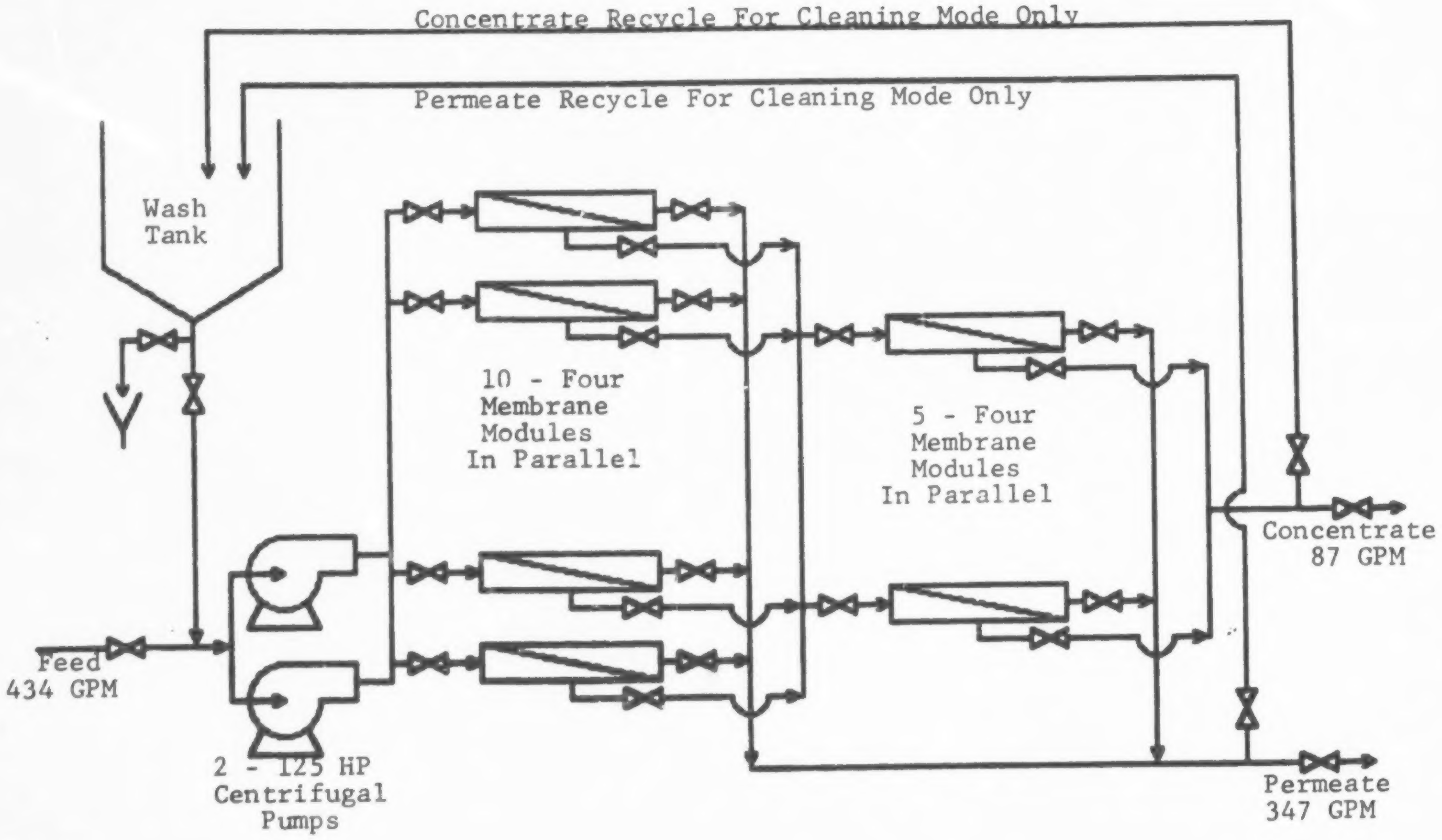
Number of membranes required = 58

15 four membrane modules will be required.

### G.8.2 Equipment List and Purchase Costs

| | |
|---|---|
| Purchase cost of one 58 membrane system (engineering and assembly work completed) | $429,859 |
| Purchase cost of equipment | $429,859 |

FIGURE G-5 SPIRAL REVERSE OSMOSIS SYSTEM FOR ULTRAFILTRATION PERMEATE.


Concentrate Recycle For Cleaning Mode Only
Permeate Recycle For Cleaning Mode Only
Wash Tank
10 - Four Membrane Modules In Parallel
5 - Four Membrane Modules In Parallel
Concentrate 87 GPM
Feed 434 GPM
2 - 125 HP Centrifugal Pumps
Permeate 347 GPM

### G.8.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 429,859 | |
| Shipping charges | | 21,493 | |
| Installation of equipment | | 25,792 | |
| Foundations | | 21,493 | |
| Instruments | | 25,792 | |
| Piping | | 21,493 | |
| Insulation | | 30,090 | |
| Electrical | | 34,389 | |
| Buildings & structures | | 42,986 | |
| Serivces | | 34,389 | |
| Misc. | | 21,493 | |
| Taxes | Federal | $70,927 | |
| TOTAL DIRECT COSTS | | | $780,194 |
| Construction and field expenses | | 39,010 | |
| Engineering expenses | | 46,812 | |
| Contractors fees | | 43,301 | |
| Contingencies | | 86,602 | |
| TOTAL INDIRECT COSTS | | | $215,724 |
| TOTAL COSTS | | | $995,918 |

### G.8.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning Chemicals (wash every 2 days) | $25,550/year |
| Replacement Membranes (every 3 years) | $36,540/year |
| Labour (shared with other parts of plant) | |
| (1/2 shift/day at $135/day) | $16,875/year |
| Energy | |
| Electrical Power | $22,050/year |
| (250 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | |
| Miscellaneous | $4,000/year |
| Contingency | $10,500/year |
| Total Operating Costs | $115,515/year |

## G.9 **Pretreatment for Reverse Osmosis Unit**

### G.9.1 Design Parameters

System consists of; 1) skim tank with demulsifier addition, oil skim, and sludge take off. 2) induced gas flotation (IGF), 3) intermediate storage tank with a gas blanket, 4) sand filter, and 5) cartridge filter unit.

Feed flowrate = 434 US.GPD

Demulsified = RTC 323 (200 ppm)

Skim tank nominal retention time = 2 h

Skim tank effluent oil concentration = 20 - 30 ppm

Storage tank volume = 125,000 US.GAL

Sand filter effluent oil concentration = 5 - 8 ppm

Cartridge filter effluent oil concentration = 1 - 2 ppm

### G.9.2 Equipment List and Purchase Costs

| | |
|---|---|
| Demulsifier addition equipment | $5,000 |
| Skim tank 46,000 US gal. | $180,000 |
| Induced gas flotation unit, Wimco#66 | $130,000 |
| Intermediate storage tank | $45,500 |
| Sand filter, Eimco 2 8' diameter units | $60,000 |
| Cartridge filter, Wix facet filter 34R3-CF30CIH | $8,000 |
| Purchase cost of equipment | $428,500 |

### G.9.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 428,500 | |
| Shipping charges | | 42,850 | |
| Installation of equipment | | 64,275 | |
| Foundations | | 42,850 | |
| Instruments | | 42,850 | |
| Piping | | 128,550 | |
| Insulation | | 85,700 | |
| Electrical | | 34,280 | |
| Buildings & structures | | 42,850 | |
| Serivces | | 51,420 | |
| Misc. | | 21,425 | |
| Taxes | Federal | $98,555 | |
| TOTAL DIRECT COSTS | | | $1,084,105 |
| Construction and field expenses | | $108,411 | |
| Engineering expenses | | $81,308 | |
| Contractors fees | | $63,691 | |
| Contingencies | | $127,382 | |
| TOTAL INDIRECT COSTS | | | $ 380,792 |
| TOTAL COSTS | | | $1,464,897 |

### G.9.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Demulsifier RTC 323, 200 ppm @ $2.00/Kg | $345,381/year |
| Cartridge filter replacement | |
| (34 filters, 12 times/yr, @ $9.30 each) | $3,794/year |
| Labour (4 shifts/day at $135/day) | $135,000/year |
| Energy | |
| Electrical Power | |
| (skim tank 10 HP, IGF=30 HP, pump at 40HP) | |
| (80 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | $7,055/year |
| Miscellaneous | $10,000/year |
| Contingency | $50,000/year |
| Total Operating Costs | $551,230/year |

## G.10 **Spiral RO System for IGF and Filtered Water**

### G.10.1 Design Parameters

Feed flowrate = 625,000 US.GPD = 434 US.GPM

Permeate flowrate = 500,000US.GPD = 347 US.GPM

Concentrate flowrate = 125,000 US.GPD = 87 US.GPM

Percent recovery = 80%

Operating temperature = 35°C

Operating pressure = 600 psi

Membrane type = 8" diameter x 40" spiral TFC Seawater

Membrane surface area = 350 $ft^2$/module

Assumed flux rate = 0.775 $M^3/M^2 \cdot D$

= 19.8 $USG/F^2 \cdot D$

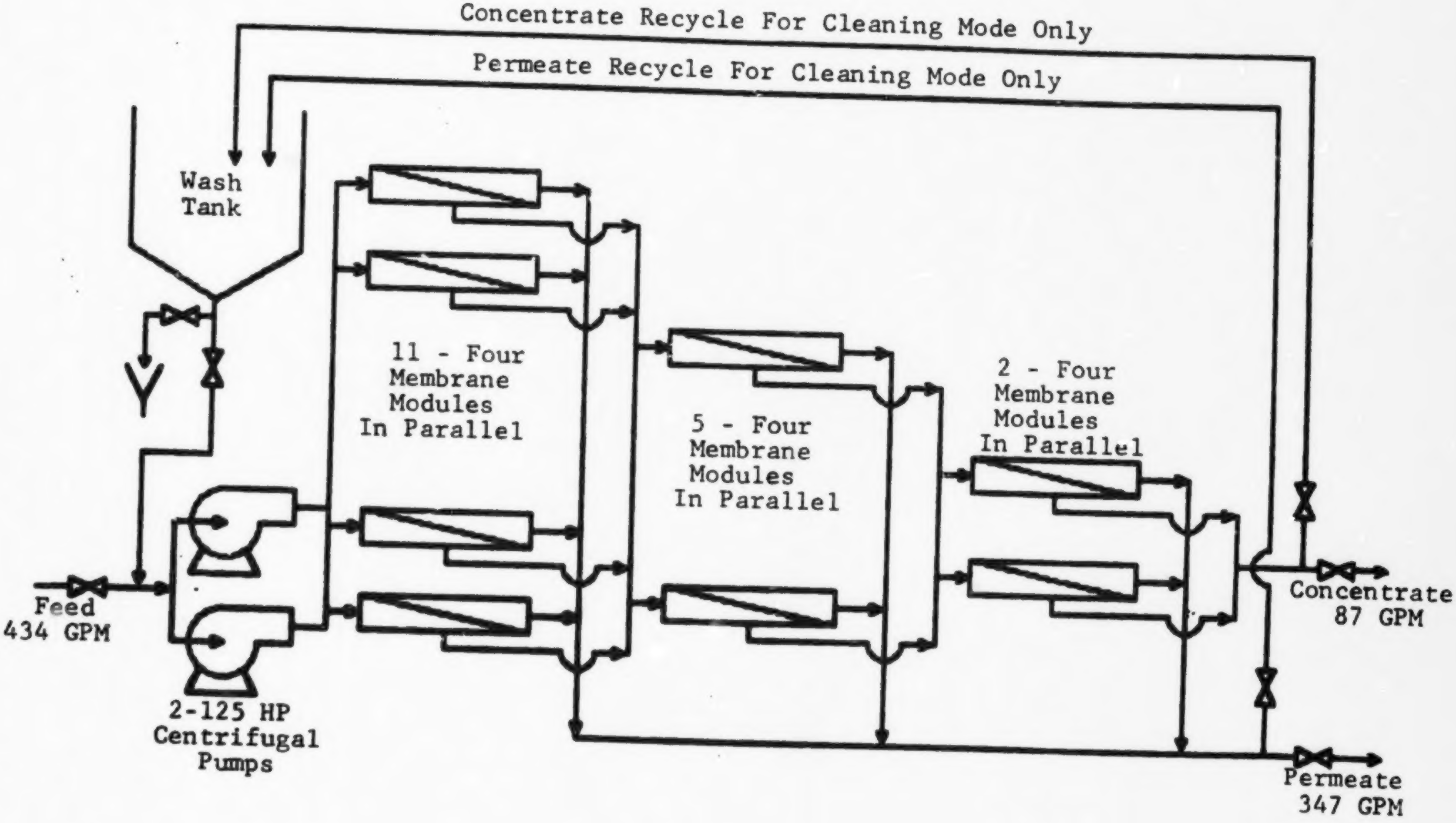
Number of membranes required = 72

18 four membrane modules will be required.

### G.10.2 Equipment List and Purchase Costs

| | |
|---|---|
| Purchase cost of one 72 membrane system<br>(engineering and assembly work completed) | $480,298 |
| Purchase cost of equipment | $480,298 |

FIGURE G-6 SPIRAL REVERSE OSMOSIS SYSTEM FOR DEMULSIFIED PRODUCED WATER.


Concentrate Recycle For Cleaning Mode Only
Permeate Recycle For Cleaning Mode Only
Wash Tank
11 - Four Membrane Modules In Parallel
5 - Four Membrane Modules In Parallel
2 - Four Membrane Modules In Parallel
Feed 434 GPM
2-125 HP Centrifugal Pumps
Concentrate 87 GPM
Permeate 347 GPM

## G.10.3 Total Cost of Installed Equipment

| | | | |
|---|---|---|---|
| Purchased cost of equipment | | $ 480,298 | |
| Shipping charges | | 24,015 | |
| Installation of equipment | | 28,818 | |
| Foundations | | 24,015 | |
| Instruments | | 28,818 | |
| Piping | | 24,015 | |
| Insulation | | 33,621 | |
| Electrical | | 38,424 | |
| Buildings & structures | | 48,030 | |
| Serivces | | 38,424 | |
| Misc. | | 24,015 | |
| Taxes | Federal | $79,249 | |
| TOTAL DIRECT COSTS | | | $871,741 |
| Construction and field expenses | | 43,587 | |
| Engineering expenses | | 52,304 | |
| Contractors fees | | 48,382 | |
| Contingencies | | 96,763 | |
| TOTAL INDIRECT COSTS | | | $ 241,036 |
| TOTAL COSTS | | | $1,112,777 |

### G.10.4 Operating and Maintenance Costs

| | |
|---|---|
| Materials | |
| Cleaning Chemicals (wash every 2 days) | $25,550/year |
| Replacement Membranes (every 3 years) | $43,848/year |
| Labour (shared with other parts of plant) | |
| (1/2 shift/day at $135/day) | $16,875/year |
| Energy | |
| Electrical Power | $22,050/year |
| (250 HP x 0.7457 x 24 x 365 x 1.35 cents/KW) | |
| Miscellaneous | $4,000/year |
| Contingency | $11,200/year |
| Total Operating Costs | $123,523/year |